

6.0 SOURCES OF SPENT PULPING LIQUOR LOSSES

6.1 Kraft and Soda Mills

Losses of black liquor from kraft and soda pulping and chemical recovery processes arise from "normal" process operations, including maintenance practices; planned startups and shutdowns of evaporators, concentrators, and recovery boilers; grade changes; other intentional liquor diversions; and losses from screen rooms, brownstock washers, and deckers. In the absence of adequate collection and recovery (or controlled rate of release to the wastewater treatment plant), intentional diversions can have the same adverse impacts as a spill of similar size. Unintentional losses result from fiber and liquor spills, equipment leaks, tank overfillings, and process upsets.

The main difference between kraft and soda pulping is that sulfur compounds are not added in soda pulping. Soda pulping is less efficient than kraft pulping, which results in more black liquor production per ton of pulp and correspondingly larger recovery systems at soda mills than at equivalent-sized kraft pulp mills. Because of the absence of sulfur compounds, soda mills are not characterized by strong TRS odors and thus do not have the extensive TRS control systems common to kraft mills. Otherwise, the pulping and chemical recovery systems are similar. Based on evaluations conducted at several kraft mills and at one soda mill, EPA identified the following significant sources of black liquor losses from normal process operations:

- Leaks from seals on brownstock washers;
- Leaks from seals on pumps and valves in black liquor service;
- Intentional liquor diversions during shutdowns, startups, grade changes, and equipment maintenance;
- Sewered evaporator boil-out solutions;
- Decker losses at older mills with open screen rooms; and
- Losses from knotters and screens at mills without fiber and liquor recovery systems for those sources.

Process upsets, equipment breakdowns, tank overfillings, construction activities, and operator errors were identified as the most common sources of unintentional black liquor and causticizing area sewer losses.

6.2 Sulfite Mills and Semi-Chemical Mills

Although the pulping systems at sulfite and semi-chemical mills are based on different process chemistry and different chemical recovery facilities, spent pulping liquor losses from normal process operations and unintentional losses at these mills arise from many of the same types of sources as at kraft and soda mills.

6.3 Summary of Reported Pulping Liquor Spills

Through its Emergency Response Notification System (ERNS), EPA maintains a database of reported spills of oil and other materials. The ERNS Standard Report Database was searched for the period January 1988 to March 1993 using key words relating to pulping liquors (e.g., black liquor, green liquor, white liquor, red liquor, pulping liquor) to determine the reported number of pulping liquor spills, the volume of spilled material, the affected media, and the reported causes of the spills (20). The ERNS Standard Report Database does not contain information about environmental impacts caused by spills.

The reporting of spills by the industry does not appear to be uniform. Some of the reported spills were minor in nature and were confined to the mills. On the other hand, relatively large sewer losses of black liquor observed at a number of mills over the past few years do not appear in the ERNS Standard Report Database. Hence, the information obtained from the ERNS Standard Report Database is not considered a comprehensive measure of pulping liquor losses across the industry, especially with regard to spills and losses confined to mills and directed to wastewater treatment systems. Despite these limitations, the information regarding the causes of the spills is informative and useful for planning new and upgraded pulping liquor spill, prevention, and control programs.

A summary of the pulping liquor spills is provided in Table 6-1. The 82 reported incidents included 59 black liquor spills, 12 white liquor spills, 10 green liquor spills, and 1 red liquor spill at a sulfite mill. Table 6-1 provides a breakdown of spills between those spilled to land (soil) and those spilled to water (sewer system, basins, wastewater treatment plant, or receiving waters). Those spills to water that reach receiving waters without being contained or treated are further broken out on Table 6-1.

It can be seen that the largest portion of reported small spills (<1,000 gallons) do not reach receiving waters, whereas more than half of the reported spills greater than 10,000 gallons did reach receiving waters. Approximately 40% of those spills of unknown volume were reported to have reached receiving waters. The two spills of greater than 50,000 gallons included a 96,000-gallon black liquor spill in Maine and a 90,000-gallon green liquor spill in Florida. The ERNS reports do not include information on the effect of the spills on wastewater treatment plants or the extent of pass-through (20).

The reported causes of pulping liquor spills were as follows:

- Mechanical Failure (45%);
- Human Error (20%);
- Tank Overfilling (16%);
- Deliberate (4%);
- Weather (1%);
- Power Failure (1%); and
- Unknown (13%).

Many of the mechanical problems involved malfunctioning valves, flanges, and pumps; pipeline corrosion; and a lack of preventive maintenance. In addition to tank overfillings, which resulted primarily from human error, liquor losses attributed to human error also included improper closure of valves and vehicular accidents inside and outside the pulp mills (20).

6.4 Untreated Wastewater Loadings for Kraft Mill

Of the untreated BOD₅ wastewater loading at a kraft pulp mill with open screen rooms, about one-third can be attributed to decker filtrate; one-third to one-half can be attributed to intermittent, uncontrolled losses; and the balance can be attributed to sewer-contaminated condensates (2). Much of the BOD₅ loading from decker filtrate and intermittent, uncontrolled losses is attributable to black liquor (2).

The reduction of brownstock washing losses is an important aspect of process optimization, as well as a pollution prevention technique, particularly at bleached kraft mills, because the increased formation of chlorinated organics and higher sewer loadings of AOX and BOD₅ have been attributed to poor brownstock washing. However, spent pulping liquor losses to the pulp after brownstock washing (i.e., soda losses attributable to residual liquor remaining in the brownstock pulp after washing) are not included in this BMP discussion or in 40 CFR 430.03, since improved brownstock washing is a part of the model process technology trains considered in the development of BAT, NSPS, PSES, and PSNS for bleached papergrade kraft and soda mills.

Table 6-2 provides untreated wastewater loadings from a typical bleached kraft mill (2). These data indicate that pulping and chemical recovery processes account for nearly 15 kilograms (kg) BOD₅ per air-dried metric ton (ADMT) of pulp, or nearly 38% of the total raw waste loading. For an unbleached kraft mill, the raw waste loading from pulping and chemical recovery processes would approach 60% of the total mill loading. Nearly all of the BOD₅ loading from pulping and chemical recovery operations originates in foul condensates and losses of spent pulping liquor.

NCASI estimates that the BOD₅ loading to the recovery circuit from weak black liquor is 360 kg/ADMT of pulp (21). NCASI also advises kraft mill operators to assume 2% liquor losses in estimating emissions for Superfund Amendments and Reauthorization Act (SARA) Section 313 reporting purposes (22). These estimates imply that BOD₅ raw wastewater loadings from "normal" liquor losses are slightly more than 7 kg/ADMT. The practical lower limit in BOD₅ raw wastewater loadings that can be attained from spill prevention is reported at 5 kg/ADMT,

and the estimated BOD₅ raw waste loading from a typical kraft mill is also reported at 5 kg/ADMT for pulping and chemical recovery operations (2).

6.5 Untreated Wastewater Loadings for Sulfite Mill

Table 6-3 presents approximate untreated wastewater loadings normalized to pulp production for two sulfite mills. At both mills, most of the BOD₅ wastewater loading is associated with pulping and chemical recovery operations. For the calcium-based sulfite pulp mill, the relatively high untreated BOD₅ wastewater loadings result from the external (off-site) recovery of lignin chemicals, in which wastewaters and condensates are processed at an adjacent facility and returned to the mill for treatment and discharge.

Based on data supplied in survey questionnaires, the overall BOD₅ levels in untreated wastewaters from ammonia-based mills and specialty mills are similar to those shown in Table 6-3. By virtue of the use of similar processing steps and equipment, these mills should exhibit comparable BOD₅ and TSS loadings for the pulping, recovery and washing areas.

Table 6-1

**Summary of Reported Pulping Liquor Spills
EPA Emergency Response Notification System (ERNS) Database
(January 1988 - March 1993)**

Volume Spilled (gallons)	Number of Reported Spills			
	Total	Media Affected		
		Land	Water (All Types)*	Receiving Waters
< 100	21	18	3	3
100 to < 1,000	12	7	5	5
1,000 to < 5,000	15	9	6	5
5,000 to < 10,000	--	--	--	--
10,000 to < 50,000	5	1	4	3
> 50,000	2	1	1	1
Unknown Volume	27	11	16	11
Total	82	47	35	28

Source: EPA ERNS, 1993 (20)

*Includes sewer system, WWTP, basins, and direct to receiving waters.

Table 6-2**Typical Untreated Wastewater Loadings From a Typical Bleached Kraft Mill**

Process	Flow (m³/ADMT (%))	TSS (kg/ADMT (%))	BOD₅ (kg/ADMT (%))
Wood Yard	0.7 (4.8)	3.1 (6.2)	0.8 (2.3)
Pulping	21 (14.3)	4.9 (10.0)	9.4 (26.3)
Recovery	17 (11.9)	11.1 (22.5)	4.1 (11.4)
Bleaching	48 (33.3)	4.9 (10.0)	12.7 (35.4)
Paper Manufacturing	52 (35.7)	25.3 (51.3)	8.9 (24.6)
TOTAL	138.7 (100)	49.3 (100)	35.9 (100)

Source: Springer, 1986 (2)

Table 6-3**Examples of Untreated Wastewater Loadings for Two Sulfite Mills**

Process	Flow (m³/ADMT (%))	TSS (kg/ADMT (%))	BOD₅ (kg/ADMT (%))
Mill E - Calcium			
Acid Making, Pulping, Washing, Bleaching		32.9 (57)	69.1 (38)
External Recovery		--	77.0 (42)
Wet Air Oxidation		2.5 (4)	18.5 (10)
Paper Machines		22.2 (39)	17.7 (10)
TOTAL		57.6 (100)	182.3 (100)
Mill F - Magnesium			
Pulping and Recovery, Washing, Bleach Plant	67 (47)	34.1 (41)	71.2 (80)
Paper Machines	76 (53)	48.1 (59)	18.1 (20)
TOTAL	143 (100)	82.2 (100)	89.3 (100)

Source: EPA Mill Visit Reports: Mills E and F; 1992
Pulp, Paper and Paperboard Effluent Limitations Guidelines

7.0 SPENT PULPING LIQUOR MANAGEMENT, SPILL PREVENTION, AND CONTROL: CURRENT INDUSTRY PRACTICE

7.1 Kraft and Soda Mills

Current industry practice with regard to spent pulping liquor management, spill prevention, and control was evaluated through the performance of numerous mill visits and an evaluation of the results of a NCASI BMP survey of kraft and sulfite mills (23). Site visits were conducted at more than 30 kraft mills, 5 sulfite mills, and 1 soda mill. These mills were selected for site visits based on age, size, discharge status (direct and indirect), and pulping practice (kraft mill, soda mill, ammonia base, magnesium base, and calcium base sulfite). The kraft and soda mills ranged from mills constructed in the early 1900s to relatively new greenfield mills constructed in the mid to late 1980s. The age of the sulfite mills ranged from 70 to 90 years. The NCASI BMP survey elicited responses from more than 60 mills; site visits were conducted by EPA at many of these mills.

Information obtained from the mill visits and the BMP survey was used to classify each bleached kraft and sulfite mill subject to the BMP regulation into one of three BMP implementation categories. These initial mill classifications were supplemented and verified by mill operators through the American Forest and Paper Association (AF&PA) for virtually all bleached papergrade kraft and soda and papergrade sulfite mills subject to the BMP regulation promulgated at 40 CFR 430.03, as well as for dissolving kraft and dissolving sulfite mills (24).

Based on findings from the mill visits and on information provided by several mill operators, industry efforts at kraft spent pulping liquor management, spill prevention, and control can be classified as either mostly proactive or mostly reactive. The proactive spent pulping liquor management programs are characterized by the following features:

- Management of process operations to minimize variability to the maximum extent possible;

7.0 Spent Pulping Liquor Management, Spill Prevention, and Control:
Current Industry Practice

- A high level of management commitment, and operator awareness and training (operators are required to address spent pulping liquor losses);
- Extensive preventive maintenance programs for spent pulping liquor equipment;
- Automated spill detection and spent pulping liquor recovery systems in the pulping and recovery areas that are maintained and operated by pulping and recovery personnel;
- Secondary containment and/or high-level alarms on weak and strong spent pulping liquor tanks;
- Frequent operator surveillance of spent pulping liquor equipment and tanks, and immediate repairs to this equipment;
- Sufficient capacity (250,000 gallons to > 1,000,000 gallons) for the storage of spilled materials and planned liquor diversions;
- Systems to recover fiber and spent pulping liquor from knotting and screening operations; and
- Secondary monitoring and diversion systems for all major mill sewers that serve pulping, recovery, and recausticizing areas.

In the reactive spent pulping liquor management programs, spill response is emphasized more heavily than spill prevention. Wastewater treatment plant operators most often use conductivity monitoring systems to detect problems in the major mill sewers and at the influent to the treatment plant. Typically, it is their responsibility to notify pulping and chemical recovery superintendents of any detected problems. In these instances, the pulping and chemical recovery areas of the mills generally do not have primary responsibility for spill detection.

For many of the proactive pulping liquor management programs, engineering controls and monitoring systems observed at kraft and soda mills are consistent with those recommended by NCASI in 1974 (21). NCASI Technical Bulletin No. 276 contains recommended approaches for spill containment for all aspects of pulp and paper mill operations, sewer monitoring, and management programs.

7.1.1 Management Commitment

Operators at mills with effective control systems stress the importance of management commitment, operator awareness and training, preventive maintenance, and daily management of spent pulping liquor inventories. These factors are cited as more important than the presence of collection and containment systems. The emphasis at these mills is clearly on proactive approaches to prevent spent pulping liquor losses and spills at the process areas, rather than on reactive responses to losses and spills that occur.

At mills with effective spent pulping liquor control systems, operators conduct walk-through of critical process areas at least once per shift to identify problems. The operators can initiate minor repairs, such as tightening pump packings, on the spot. More extensive repairs are addressed through work order systems, and repairs are completed quickly.

Mill operators of the most effective spent pulping liquor control systems also conduct daily trend analyses of sewer losses at critical locations to detect low-level leaks and spills at an early stage. Most operators use conductivity to measure losses; others use COD analyses of grab or daily composite samples. At one mill, operators use a one-day BOD₅ test to detect losses of spent pulping liquor and soap. The results are plotted daily, and statistical process control is used to assist the operators in identifying trends and target areas for surveillance and repair. The target sewer-loss levels are reviewed periodically and reduced over time as part of a continuous improvement program. At this mill, shift operators are provided with information to determine spent pulping liquor loss control performance, as well as tools to correct problems as they arise, within established parameters.

Most engineers agree that it is easier to install effective spill control systems during the design and construction of new mills than to retrofit such systems into old mills. However, EPA visited two of the oldest bleached kraft mills in the United States, both originally constructed in the early 1900s. Each of these mills has two pulping lines. Each mill also has dry debarking, effective

brownstock washing, closed screen rooms, spill sumps with conductivity alarms in all black liquor areas (about five sumps at each mill), and conventional secondary biological treatment systems. Both mills have spent pulping liquor spill storage tanks considerably smaller than those discussed in Section 9.0 of this report. Neither mill has any staff dedicated to spill control, but the philosophy of "do not spill" is evident in all production activities. This philosophy has been developed by formal training and continuous emphasis on avoiding spills in daily management and supervisory activities. Neither mill has any accounting of the labor cost of spill control. Although such costs are not trivial, they are certainly less than the costs for installing extensive effluent treatment systems to achieve similar effluent quality from an equivalent mill with poor spill control. One mill discharges an average of 21 kg COD/ADMT, and the other mill discharges 28 kg COD/ADMT. Color discharges average 43 kg/ADMT and 28 kg/ADMT, respectively. These data are monthly averages. Technical personnel at these mills believe that operator training and awareness is the most significant feature of their effective spill control programs.

7.1.2 Equipment Requirements

As described above, mill operators confirm that the non-hardware aspects of spent pulping liquor management and control are by far the most important aspects of minimizing liquor losses and adverse impacts on wastewater treatment systems. Nonetheless, some hardware is necessary to effectively control and manage intentional spent pulping liquor diversions and unintentional losses and spills. Effective systems are designed with the following concepts:

- Identification of discrete spill collection areas in process areas with the potential for significant liquor and fiber losses (i.e., brownstock washing lines, evaporators, digesters, recovery boilers, tank farms, etc.) and installation of strategically located liquor collection sumps in each area;
- Diversion of clean streams from potential spill areas to avoid dilution of recovered spent pulping liquors;

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- Collection of diverted or spilled liquor at the highest possible liquor solids concentration;
- Return of collected liquor and fiber to the process at appropriate locations;
- Curbing and diking to isolate critical process areas (including soap and turpentine processing areas) from the wastewater treatment facilities; and
- Conductivity monitoring at strategic locations to detect losses and spills.

Mill operators can divert floor trench drains around brownstock washers by gravity flow to collection tanks. To further avoid dilution, weak spent pulping liquor can be used for washdowns in the washer areas. Many operators collect concentrated evaporator boil-out solutions and liquor diverted from recovery boilers during maintenance for reclamation before dilution with other waters. Several mills have installed fiber reclaim tanks and fiber filters to recover fiber from losses in the digester and washer areas. As noted above, the approach taken by many mill operators is to establish discrete spill and liquor recovery areas in critical process areas (e.g., digesters, evaporators, recovery boilers, brownstock washers, knotters, and screens) and to provide liquor collection sumps for each area. These mills use flow-through conductivity-actuated liquor collection sumps to collect liquor at preset conductivity levels that reflect liquor solids concentrations that can be recovered economically.

Figure 7-1 provides a plot of black liquor solids versus (vs.) conductivity for a southern unbleached kraft mill for a range of 0 to 16% black liquor solids (25). These data show a high correlation between conductivity and the percent of liquor solids. Although these results may not be directly applicable to all kraft mills, they are presented to demonstrate the high correlation of conductivity to liquor solids, which supports the use of conductivity as a surrogate measure of pulping liquor losses for day-to-day mill operations.

There are two approaches regarding the volume of spent pulping liquor storage capacity that is needed to operate effective spill control systems. One approach holds that the volume of available capacity should be as large as possible to allow for the collection of large volumes of

spilled or diverted liquor. The other approach holds that the volume of available spill storage capacity should be as low as possible to foster minimal process variability, more effective liquor management, and preventive maintenance.

The latter approach was found at the mills that have been operating effective spent pulping liquor control systems for many years. The large-capacity approach appears to be more prevalent in mills that are currently investigating and installing spent pulping liquor containment systems. Thus, mill operators with long and successful experience in spent pulping liquor spill control favor minimal-capacity liquor spill storage tanks, while many of those working on theoretical new designs of spent pulping liquor systems favor large-capacity liquor spill storage tanks. At mills where spill storage capacity is large, there is the potential for shift operators to pass a problem to the next shift rather than to deal with it immediately. Based on an evaluation of mills with effective spent pulping liquor control systems, a moderate amount of liquor spill capacity is necessary, but the amount should be minimized to foster spill prevention, rather than spill collection and control. A summary of black liquor storage capacity data for two kraft mills and one soda mill are presented in Table 7-1. Pulping liquor storage capacity data for three sulfite mills are presented in Table 7-2.

Process area curbing and diking are also important to isolate process areas from wastewater treatment systems by diverting spilled or diverted spent pulping liquor to appropriate liquor collection sumps and diverting stormwater "run-on" from entering liquor collection sumps, to the extent practical. Process area curbing and diking for soap and turpentine processing areas help prevent adverse impacts on wastewater treatment systems from spills and losses of these materials, which can be high in toxic materials and BOD₅. Soap is a material that is high in organic content (850,000 to 950,000 mg/L of BOD₅ reported for one mill (26)) and toxic to aquatic life and micro-organisms in biological treatment systems. Soap does not contribute significantly to conductivity; thus, soap spills and losses are not detected by conductivity-based monitoring systems unless pulping liquor is also present. Turpentine is also highly toxic and also does not contribute significantly to conductivity. Consequently, it is important to minimize the

risk of accidental losses of these materials from processing areas and storage tanks through proper operation and design, and frequent visual inspections and secondary containment where feasible. EPA site visits and the NCASI BMP survey have shown that most mills provide secondary containment for turpentine storage tanks and have taken measures to prevent turpentine and soap spills from reaching wastewater treatment systems.

7.1.3 Economical Recovery of Spent Kraft Pulping Liquors

The concentration of black liquor solids at which dilute black liquors can be economically recovered depends on several factors. The benefits of recovering black liquor losses are as follows:

- Energy value;
- Cost of replacement chemicals, primarily equivalent saltcake;
- Reduction in BOD₅ load on the effluent treatment system; and
- Reduction in color and COD discharge in the treated effluent.

The energy value and cost of replacement chemicals can readily be calculated on a mill-specific basis, while the values associated with effluent reductions are more difficult to ascertain. A brief discussion of liquor solids levels that may be economical to recover at a typical bleached papergrade kraft mill (27) is presented below.

The value of recovered chemicals is significant in cases where mills purchase saltcake. However, for today's bleached papergrade kraft mills, where high chlorine dioxide substitution and effective brownstock washing are becoming the norm, there is usually an excess of saltcake. It is likely that less than half of the bleached kraft mills in the United States can assign a credit for recovered saltcake, and that very few mills will be able to do so in the future as brownstock washing and bleaching operations are upgraded.

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Assuming a typical evaporator steam economy of 4.5 (kg of water evaporated per kg of steam) and a recovery boiler efficiency of 60%, the combustion of 1 kg of black liquor solids produces sufficient steam to evaporate about 18 kg of water. The recovery of 1 kg of black liquor solids will also reduce the BOD₅ load on the effluent treatment system by about 0.15 kg, which in turn will reduce operating costs by approximately 5 cents. This amount is equivalent to the cost of steam to evaporate about 6 kg of water.

Therefore, in most bleached kraft mills where excess saltcake is produced, the financial value of recovering 1 kg of black liquor solids is equivalent to evaporating about 24 kg water (18 kg + 6 kg). In this case, the break-even liquor solids concentration, the point at which evaporation costs are equal to the value of the recovered liquor, is approximately 4%. At mills where recovered liquor will offset the need to purchase saltcake, the economical liquor solids concentration for recovery can be as low as 1%.

Where a mill lacks sufficient evaporator capacity, the break-even cost will be higher because the mill will need to allow for increasing the evaporator capacity. Conversely, there could be substantial investment and operating cost savings in cases where spent pulping liquor spill recovery systems reduce or eliminate the need for treatment of the effluent color or the expansion of a biological treatment system. Any cost credits for reducing effluent color or COD will depend on the alternative costs of compliance with each mill's discharge requirements for these pollutants, if any.

Some mills collect dilute spent pulping liquors down to 1% liquor solids and less. These mills are driven by the need to control effluent color. Other mills collect liquor solids to the point where the value of the recovered fiber, chemicals, and energy exceeds the cost of evaporating dilute liquors. These mills collect spent pulping liquor at liquor solids concentrations of 2 to 5%. As described above, this determination is highly mill-specific and depends on available evaporator capacity and saltcake balance.

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Although not required by the BMP regulation, spill prevention and control for white and green liquors at kraft mills will likely be cost-effective in many cases.

7.2 Sulfite Mills

At the sulfite mills evaluated, spent pulping liquor management, spill prevention, and control programs include many of the same features described above for kraft and soda mills. One mill has a fiber and liquor recovery system at the brownstock washers. Most of the mills do not have full secondary containment for weak and strong spent pulping liquor tanks. High-level alarms on liquor tanks appear to be standard practice. All mills are equipped with pH and/or conductivity meters and alarms at strategic locations to identify spills or upsets. Some mills have diversion tanks or ponds for large spent pulping liquor diversions or spills. Protection of the wastewater treatment facilities is the main objective for these systems. One sulfite mill reported an extensive proactive spent pulping liquor spill prevention and control program that included all of the elements described above for the kraft mills (28). The following techniques can be used to substantially minimize spent pulping liquor losses from most sulfite mills (2,28):

- Spill collection systems for the digester, pulp washing, and screening areas with recovery of fiber and spent pulping liquor losses;
- High-level alarms on spent pulping liquor and stock tanks;
- Flow recorders and continuous monitors and samplers on major process area sewers;
- Collection of tank overflows from heavy to weak liquor tanks;
- Extra equipment capacity to handle spills and upset conditions; and
- An ability to return heavy liquor and compatible boil-out solutions to weak liquor tanks instead of the sewer.

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Current Industry Practice

Table 7-1

**Black Liquor Storage Capacity - Kraft and Soda Mills
Tank Volume (Gallons) and Typical Operating Level (%)**

Tank	Mill A 1760 ADMT/day	Mill B 770 ADMT/day	Mill C 680 ADMT/day
Weak Liquor	852,000 (25 - 84%) 852,000 (25 - 84%)	1,500,000 (75%)	686,000 (25 - 75%)
Strong Liquor	177,000 (50%)	152,000 (90%)	158,000 (60 - 70%)
Strong Waste or Spill Tank	837,000 (0%)	345,000 (0%)	1,500,000 (30 - 35%)
Fiber Salvage	57,000 (20 - 35%)		
Intermediate Liquor		345,000 (0%)	
Wastewater Diversion Basin		5,000,000	

Source: EPA Project Files: Mill Visit Reports; Mills A, B, and C; 1992
Pulp, Paper and Paperboard Effluent Limitations Guidelines

7.0 Spent Pulping Liquor Management, Spill Prevention, and Control:
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Table 7-2

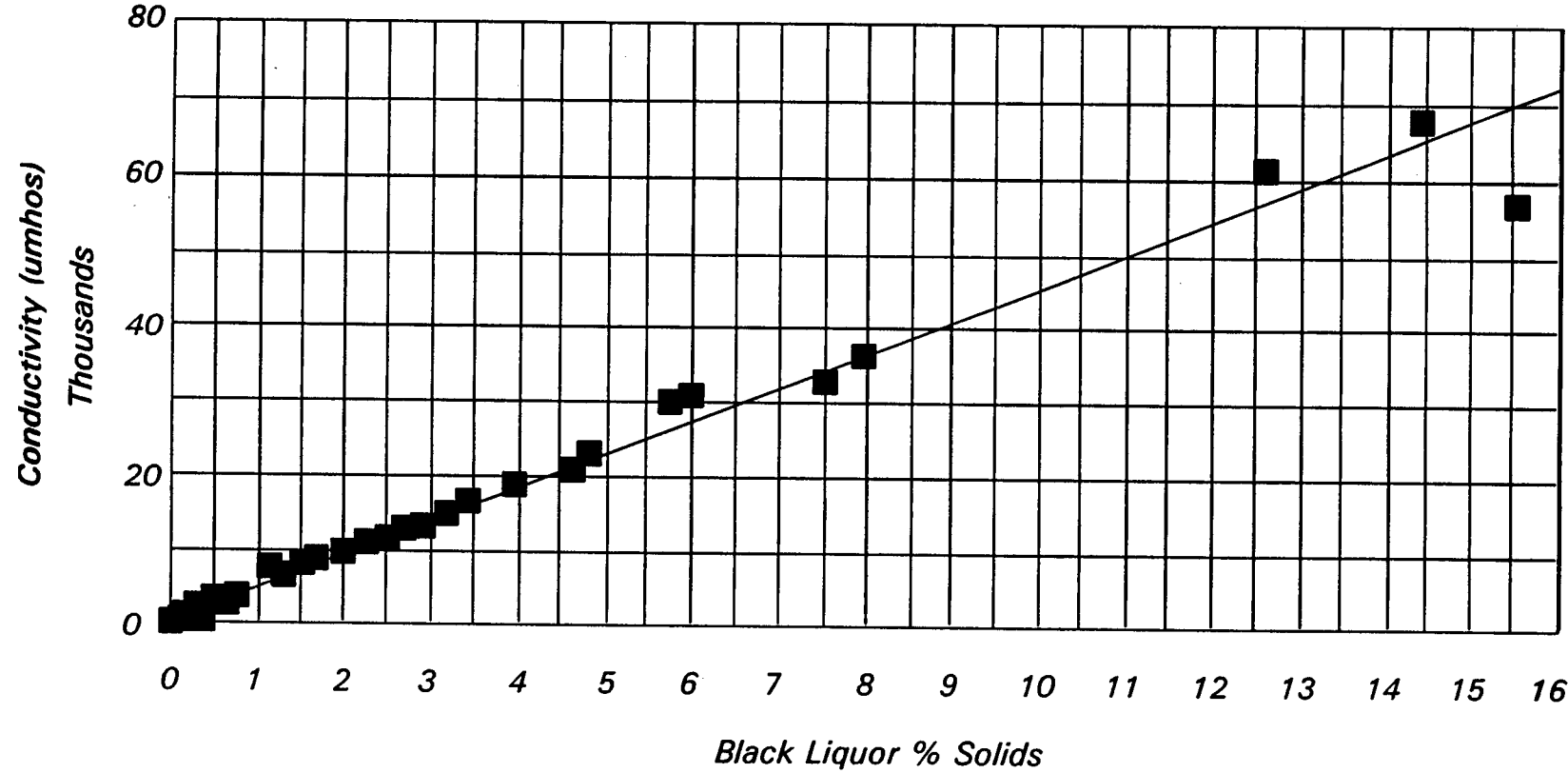
Pulping Liquor Storage Capacity - Sulfite Mills
Tank Volume (Gallons) and Typical Operating Level (%)

Tank	Mill E 180 ADMT/day	Mill F 210 ADMT/day	Mill G 140 ADMT/day
Accumulators	65,000 (80%) 95,500 (70%)	50,000 (50%)	
Fresh Acid Storage	85,000 (50%)	300,000 (65%)	
Weak Liquor Storage	88,000 (60%)	1,650,000 (50%)	
Strong Liquor Storage		1,650,000 (50%)	
Diversion Tank or Basin	1,200,000 (40%)	Not specified	5,000,000

Source: EPA Project Files: Mill Visit Reports; Mills, E, F, and G; 1992
Pulp, Paper and Paperboard Effluent Limitations Guidelines

Figure 7-1

Black Liquor Solids vs. Conductivity



R Squared = 0.976

Source: PCA, 1995 (25)

8.0 BMP REGULATORY APPROACH, REQUIREMENTS, AND IMPLEMENTATION

8.1 Regulatory Approach and Regulatory Requirements

EPA's regulatory approach for controlling losses of spent pulping liquor is to require, by regulation, that the owner or operator of each chemical pulp mill subject to the regulation implement Best Management Practices (BMPs) to prevent and control spent pulping liquor losses, other than those losses associated with normal brownstock pulp washing, and to prevent and control losses of turpentine and soap. Mills subject to the regulation are further required to prepare and maintain a BMP Plan addressing elements noted later, and to review and revise the plan as specified in the regulation. For direct dischargers, this requirement will be implemented through their NPDES permits. Existing direct dischargers are subject to the compliance dates established in the regulation, while new sources must comply immediately upon commencing discharge except where noted. As pretreatment standards, these BMP requirements apply directly to indirect dischargers, subject to the compliance dates established in the regulation.

In many respects, the BMP Plan will be similar to the Spill Prevention Countermeasure and Control (SPCC) Plans for oil spill prevention and control (see 40 CFR 112.7). The primary objective of the BMPs is to proactively prevent losses and spills of spent pulping liquors, soap, and turpentine; a secondary objective is to reactively collect, contain, recover, or otherwise control spills and losses that do occur. Pulp mill operators should ensure that no leaks or spills of spent pulping liquors are visible in their mills.

The BMPs are as follows:

1. The mill must return diverted or spilled liquor to the process to the maximum extent practicable as determined by the mill, recover such materials outside the process, or discharge spilled or diverted material at a rate that does not disrupt the receiving wastewater treatment system. Based on EPA's review of effective BMPs at selected mills, preventative maintenance practices, standard operating procedures and engineering

8.0 BMP Regulatory Approach, Requirements, and Implementation

controls are essential elements to ensure the objectives of the BMP regulation are met on a mill-by-mill basis.

2. The mill must establish a program of regular visual inspections (e.g. once per day) of process areas with equipment items in spent pulping liquor, soap, and turpentine service, and a program for repair of leaking equipment. The repair program must encompass immediate repairs when possible, and quick repair during the next maintenance outage, of leaking equipment that cannot be repaired during normal operations. The mill must also identify conditions under which production will be curtailed or halted to repair leaking equipment or to prevent spent pulping liquor, soap, and turpentine leaks and spills. Under the repair program, the mill must also establish a process for tracking repairs over time to identify equipment that may need to be upgraded or replaced, based on the frequency and severity of leaks, spills, or failures. Regular visual (and auditory) inspections by knowledgeable operators can provide an effective early warning system to detect leaks, spills and to learn about possible equipment malfunctions before they turn into more significant problems.
3. The mill must operate continuous, automatic monitoring systems that the mill determines are necessary to detect and control leaks, spills, and intentional diversions of spent pulping liquor, soap, and turpentine. These monitoring systems should be integrated with the mill process control system and may include, e.g., high level monitors and alarms on storage tanks; process area conductivity (or pH) monitors and alarms; and process area sewer, process wastewater, and wastewater treatment plant conductivity (or pH) monitors and alarms.
4. The mill must establish a program of initial and refresher training of operators, maintenance personnel, and other technical and supervisory personnel who have responsibility for operating, maintaining, or supervising the operation and maintenance of equipment items in spent pulping liquor, soap, and turpentine service. The refresher training must be conducted at least annually and should include consideration of improved BMPs as a result of experience gained in the previous year. The training must be documented, and records of training must be maintained for three years. EPA believes that initial and refresher training is necessary to ensure that operators, maintenance and supervisory personnel are familiar with the BMPs selected for implementation at the mill, and to ensure their effective implementation.
5. The mill must prepare a brief report that evaluates each spill of spent pulping liquor, soap, or turpentine that is not contained at the immediate

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process area and any intentional diversion of spent pulping liquor, soap, or turpentine that is not contained at the immediate process area. The report must describe the equipment items involved, the circumstances leading to the incident, the effectiveness of the corrective actions taken to contain and recover the spill or intentional diversion, and plans to develop changes to equipment and operating and maintenance practices as necessary to prevent recurrence. Discussion of the reports must be included as part of the annual refresher training.

6. The mill must establish a program to review any planned modifications to the pulping and chemical recovery facilities and any construction activities in the pulping and chemical recovery areas before these activities commence. The purpose of such review is to prevent leaks and spills of spent pulping liquor, soap, and turpentine during the planned modifications, and to ensure that construction and supervisory personnel are aware of possible liquor diversions and of the requirement to prevent leaks and spills of spent pulping liquors, soap, and turpentine during construction.
7. The mill must install and maintain secondary containment (i.e., containment constructed of materials impervious to pulping liquors) for spent pulping liquor bulk storage tanks equivalent to the volume of the largest tank plus sufficient freeboard for precipitation. An annual tank integrity testing program, if coupled with other containment or diversion structures, may be substituted for secondary containment for spent pulping liquor bulk storage tanks.
8. The mill must install and maintain secondary containment for turpentine bulk storage tanks.
9. The mill must install and maintain curbing, diking or other means of isolating soap and turpentine processing and loading areas from the wastewater treatment facilities.
10. The mill must conduct wastewater monitoring to detect leaks and spills, to track the performance and effectiveness of the BMPs, and to detect trends in spent pulping liquor losses (see section 8.2.5 below).

Mill owners or operators are required to prepare and implement a BMP Plan for spent pulping liquor, soap, and turpentine. EPA expects this plan to be proactive. The detailed provisions of

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each BMP Plan will be developed by mill operators and will be tailored to the specific circumstances at each mill. The BMP Plan should address the following general areas:

- Management Commitment and Approval;
- Employee Awareness and Training;
- Preventive Maintenance;
- Work Practices;
- Surveillance and Repair Programs;
- Engineering Analyses;
- Engineering Controls and Containment;
- Dedicated Monitoring and Alarm Systems; and
- Monitoring of BMP Implementation.

As part of the BMP Plan development, each mill must conduct detailed engineering review of the pulping and chemical recovery operations, including but not limited to, process equipment, storage tanks, pipelines and pumping systems, loading and unloading facilities, and other appurtenant pulping and chemical recovery equipment items in spent pulping liquor, soap, and turpentine service -- to determine the magnitude and routing of potential leaks, spills, and intentional diversions of spent pulping liquors, soap, and turpentine during the following periods of operation:

- Startups and shutdowns;
- Maintenance;
- Production grade changes;
- Storm or other weather events;
- Power failures; and
- Normal operations.

Maximum advantage for minimizing the potential for spent pulping liquor losses can be taken through thoughtful engineering analyses of affected process areas at each mill.

Each mill must also conduct a detailed engineering review of existing spent pulping liquor containment facilities to determine whether there is adequate capacity for the collection and

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storage of anticipated intentional spent pulping liquor diversions with sufficient contingency space for the collection and containment of spills, based on good engineering practice.

Secondary containment equivalent to the volume of the largest spent pulping liquor storage tank, plus sufficient freeboard for precipitation, must be provided for spent pulping liquor bulk storage tanks. Alternatively, mill operators may substitute an annual tank integrity testing program for hard secondary containment for spent pulping liquor bulk storage tanks, provided that the annual tank integrity testing program is coupled with other containment or diversion structures. Hard secondary containment must be provided for turpentine storage tanks to ensure that spills or losses of turpentine do not adversely affect wastewater treatment facilities. The flexibility to use a tank integrity testing program in lieu of secondary containment for spent pulping liquor bulk storage tanks is provided because the number of spill incidents relating to catastrophic tank failures has been relatively small, and at some mills, the location of process equipment and storage tanks would make installation of full secondary containment facilities difficult and costly in relation to the possible benefits.

The plan must include an analysis of the need for (and benefits of) continuous, automatic monitoring systems to detect and control leaks and spills of spent pulping liquor, soap, and turpentine. The monitoring plan and analysis should be conducted in conjunction with the overall engineering analysis of containment, curbing, stream segregation, operating practices, etc.

The engineering review must also consider the potential for contamination of stormwater from the immediate process areas (from digesters, evaporators, recovery boilers, etc.). Segregation and collection of contaminated stormwater from the process areas must be considered.

The plan must include a description of the monitoring program implemented to track the performance and effectiveness of the BMPs. The plan must include the statistically-derived action levels required by the BMP regulation and must also specify the period of time that the mill determines the action levels may be exceeded without triggering the responses specified in the regulation.

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The plan must include an implementation schedule not to exceed 36 months for the construction of any spent pulping liquor containment or diversion facilities necessary to fully implement the BMP Plan. An implementation schedule not to exceed 24 months should also be prepared for the installation or upgrade of continuous, automatic monitoring systems, including but not limited to, high-level monitors and alarms on existing storage tanks, process area conductivity (or pH) monitoring and alarms, and process wastewater and wastewater treatment plant conductivity (or pH) monitoring and alarms. The exact compliance dates are determined by the publication date of the regulation.

The BMP Plan must be reviewed by the senior technical manager at the mill. The BMP Plan must be approved and signed by the mill manager. A certification by a Registered Professional Engineer familiar with the facility and the requirements of the BMP regulation, although desirable, is not required by this regulation. The person signing the BMP Plan must certify to the NPDES permitting or pretreatment control authority that the BMP Plan (or amendments) has been prepared in accordance with the requirements of the regulation and in accordance with good engineering practices. Since the mill manager is ultimately responsible for approving the financial and human resources required to implement the plan, the plan must be reviewed and signed by the mill manager.

Each mill subject to the BMP regulation must amend its BMP Plan whenever there is a change in mill design, construction, operation, or maintenance that materially affects the potential for leaks or spills of spent pulping liquor, turpentine, or soap from the immediate process areas. Also, each mill subject to the regulation must complete a review and evaluation of the BMP Plan five years after the first BMP Plan is prepared and, except when amendment is required earlier due to mill changes, once every five years thereafter. As a result of this review and evaluation, the mill must amend the BMP Plan within three months of the review if the mill determines that any new or modified management practices and engineered controls are necessary to reduce significantly the likelihood of spent pulping liquor, soap, and turpentine leaks, spills, or intentional diversions

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from the immediate process areas, including a schedule for implementation of such practices and controls.

Except as noted below for new sources, indirect discharging mills subject to this section must meet the deadlines below. Also, except for new sources, NPDES permits must require direct discharging mills subject to this section to meet the deadlines below. If a deadline has passed at the time the NPDES permit containing the BMP requirement is issued, the NPDES permit must require immediate compliance with BMP requirement(s).

Upon commencing discharge, new sources subject to the regulation must implement all of the BMPs specified in the regulation, prepare the BMP Plan, and certify to the permitting or pretreatment authority that the BMP Plan has been prepared in accordance with the regulation, except that the action levels must be established not later than 12 months after commencement of discharge, based on six months of monitoring data obtained prior to that date.

The milestones and compliance dates for the BMP regulation are as follows:

	<u>Milestone</u>	<u>Compliance Date</u>
1.	Prepare BMP Plans and certify to the permitting or pretreatment control authority that the BMP Plan has been prepared in accordance with 40 CFR 430.03, not later than	12 months after date of publication ¹
2.	Implement all BMPs specified in 40 CFR 430.03 (c) that do not require the construction of containment or diversion instructions or the installation of monitoring and alarm systems not later than	12 months after date of publication
3.	Establish initial action levels required by 40 CFR 430.03 (h) not later than	12 months after date of publication

¹ This is the date the regulation is published in the Federal Register.

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	<u>Milestone</u>	<u>Compliance Date</u>
4.	Commence operation of any new or upgraded continuous, automatic monitoring systems that the mill determines to be necessary under 40 CFR 430.03(c)(3) (other than those associated with construction of containment or diversion structures), not later than	24 months after date of publication
5.	Complete construction and commence operation of any spent pulping liquor, collection, containment, diversion, or other facilities, including any associated continuous monitoring systems, necessary to fully implement BMPs specified in 40 CFR 430.03(c), not later than	36 months after date of publication
6.	Establish revised action levels required by 40 CFR 430.03(h) as soon as possible after fully implementing BMPs specified in 40 CFR 430.03(c), but not later than	45 months after date of publication

The time frames stated above were revised from compliance dates contained in the original proposal. These new milestone dates were developed based upon comments received by EPA and further consideration of the activities that must be completed for each milestone. The completion of the BMP Plan involves a number of complex engineering analyses that will require detailed examination of drawings, operating procedures, and maintenance records. The development of construction and monitoring approaches and schedules, required for the plan, will involve both engineering and operating personnel examining "incident scenarios" and alternative approaches. Supported by comments, EPA has determined that the BMP Plan and certain BMP elements related to the existing systems can be completed in 12 months (milestones 1, 2, and 3). Upon completion of the plan, an additional 12 months is allowed for specification of monitoring equipment, procurement, delivery, and installation (milestone 4). From the completion of the plan, 24 months are provided for those elements of the BMP implementation that require construction (sumps, tanks, valves, piping, curbs, etc.). This time span is provided to accommodate detailed engineering, design, specification, procurement, scheduling of equipment shutdowns, construction mobilization and construction (milestone 5).

8.2 Implementation Guidance for Permit Writers and Pretreatment Authorities

As described above, mill owners or operators will be required to develop and implement BMPs using practices and procedures that are tailored to the specific circumstances at each mill. To assist in the implementation of the regulation through the NPDES permit and pretreatment programs, implementation guidance for permit writers, pretreatment authorities, and the industry is provided in Sections 8.2.1 through 8.2.5.

8.2.1 Applicability of BMP Regulation to Pulping Liquors Other Than Spent Pulping Liquor

Although the BMP regulation is specific to spent pulping liquors, soap and turpentine, EPA anticipates that similar BMPs and controls may be implemented for white liquor, green liquor, and fresh sulfite pulping liquor at many mills; however, mill owners or operators are obligated to address only spent pulping liquor, soap and turpentine as part of the BMP regulation codified at 40 CFR 430.03. The regulation does not mandate that any particular types of controls be installed, nor that spent pulping liquor be recovered at any particular liquor solids concentration. Permitting and pretreatment authorities have additional authority under Section 402 of the CWA and the NPDES permit and pretreatment regulations at 40 CFR §403.5 and 122.44(k) to extend BMP requirements to other pulping liquors and other substances at pulp and paper mills, where they deem appropriate.

8.2.2 Requirements for Specific BMP Equipment Items

Secondary containment for turpentine storage tanks, and curbing or diking or equivalent containment for soap and turpentine processing areas, are required by the BMP regulation. Otherwise, the BMP regulation does not mandate that specific equipment items, monitoring systems, or alarm systems be used to comply with the regulation. EPA intends that mill owners or operators should have maximum flexibility to address management and control of spent

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pulping liquor at their mills, within the context of general regulatory requirements. The specific types of equipment described in Section 9.0 were selected by EPA for the purpose of developing estimated industry-wide costs to comply with the regulation. Although these equipment items and associated control strategies are among those judged to be appropriate and effective, mill owners or operators are not constrained by the regulation to use any particular equipment item or control strategy, except that spent pulping liquor bulk storage tanks require secondary containment or annual integrity testing.

8.2.3 Costs of BMP Compliance

As part of its effort to characterize the economic impact of the effluent limitations guidelines and standards on the pulp and paper mills, EPA estimated industry-wide costs to comply with the BMP regulation (see Section 9.0). EPA believes the cost estimates presented in Section 9.0 are reasonable based on comparisons made with actual costs incurred by mill operators who have implemented effective BMP programs and based on review of independent cost estimates provided by several mill operators. The BMP regulation does not require that mill owners or operators incur a specific cost to comply with the regulation.

8.2.4 Recovery of Liquor Solids Under BMP Regulation

As described in Section 7.0, the level of liquor solids that may be economical to recover is mill-specific and depends on factors such as saltcake balance, available evaporator capacity, and the need to control effluent color and other pollutants. The BMP regulation does not mandate that mill owners or operators recover dilute liquors at a particular liquor solids concentration (e.g., 1% black liquor solids). The intent of the regulation is that mill owners or operators will determine an appropriate target level of liquor solids recovery as part of the engineering review that is required by the regulation. As mills are modernized and upgraded, EPA anticipates that new pulping and chemical recovery facilities, including additional evaporator capacity, will be designed and installed to achieve more effective spent pulping liquor control.

8.2.5 Monitoring of BMP Implementation

EPA is requiring monitoring of the BMP implementation at pulp and paper mills for two reasons: (1) to provide a framework for monitoring the performance and effectiveness of BMPs on a continuing basis; and (2) to establish an early warning system to detect trends in spent pulping liquor losses that might not otherwise be obvious. The BMP monitoring program involves establishing action levels as a measure of organic loading at the point influent enters the wastewater treatment system or at another key location or locations in the mill sewer system representative of the pollutant loading of spent pulping liquor, soap, and turpentine to the wastewater treatment system. It also involves responding to exceedances of these action levels with investigative and corrective actions, as appropriate. The BMP regulation requires mill owners or operators to establish initial action levels based on at least six months of monitoring data, and to revise these levels after the BMP Plan has been fully implemented. Exceedances of the action levels will not constitute violations of NPDES permits or pretreatment standards; however, failure to conduct the required BMP monitoring, or failure to conduct investigative or corrective actions when the action levels are exceeded (as described in the regulation), would constitute permit or pretreatment standard violations.

EPA believes that COD is among the best, if not the best, pulp mill wastewater characteristic that can be monitored to fulfill this provision of the BMP regulation. COD can measure those pollutants characteristic of spent pulping liquors that are somewhat toxic and refractory to biological treatment. The test method for COD is highly reproducible and can be performed in a short period of time, unlike the BOD₅ test method. It also has the advantage of being responsive to losses of turpentine and soap, unlike conductivity, which is not responsive to these materials. Alternative pulp mill wastewater monitoring characteristics could include Total Organic Carbon (TOC), a simplified one-day BOD₅ test, or another similar short-term measure of organic loading. The objective is to use an analytical method that can be performed within one day of sampling, which will allow for timely data assessment. The regulation provides flexibility for mill owners or operators to select any reasonable measure of organic loading and/or spent

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pulping liquor losses. The BMP regulation requires daily monitoring of the wastewater treatment system influent or, alternatively, daily monitoring at other locations selected to isolate possible sources of spent pulping liquor, soap, or turpentine from the other possible sources of organic-containing wastewaters that are tributary to the wastewater treatment system. At each location, EPA expects that mass loadings of COD, TOC, or another short-term measure of organic loading will serve as a primary indicator of how well the mills are implementing their BMP Plans.

Mill owners or operators must establish statistically-derived upper and lower action levels based on six months of monitoring data. EPA expects that these data will reflect normal mill operations, with no data reflecting abnormal spills or losses of spent pulping liquor, soap or turpentine. For example, running seven-day average 75th- and 90th-percentile values may be derived and used as upper and lower control levels. When the lower action level is exceeded, mill operators must initiate appropriate investigative actions to determine the cause of such occurrence (e.g., potential abnormal liquor losses). EPA anticipates that most mills also would initiate corrective actions at this point if appropriate. If the upper action level is exceeded for the period of time specified in the BMP Plan, mill operators must initiate corrective actions to bring the monitored mass loadings of COD, TOC, or another organic measure to a level below the lower action level as soon as practicable. Subject to reissuance dates of NPDES permits (for direct dischargers), existing dischargers must establish an initial set of action levels within 12 months from date of publication of the regulation and a revised set of action levels after the BMPs have been fully implemented, but not later than 45 months from the date the regulation is published. New dischargers must establish action levels not later than 12 months after commencement of discharge.

The approach taken here is consistent with industry practice for the monitoring of many process variables and process or equipment conditions. Process annunciator panels typically supply an alert to operators, warning that they should examine a “developing” situation, such as a tank filled to an abnormally high, though not critical, level or pressure at a pump discharge lower than normal. That same annunciator would provide an alarm, usually in the form of sound and a

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flashing light, when action is needed immediately, e.g., when damage or an irretrievable process upset is imminent. The same philosophy which has led to this process control approach can reasonably be applied to the monitoring of spent pulping liquor since some losses, such as leaks at pump seals, will develop gradually and can be investigated and repaired in response to a lower action level, while a major pipe joint failure should be dealt with by immediate action if the loss rate threatens the downstream treatment capacity, as indicated by the higher action level.

It may become necessary for the mill to establish interim action levels due to changes in mill systems and operations not associated with the implementation of BMPs. These interim action levels are a temporary measure to respond to significant changes in mill design, operation, production, or maintenance that result in the existing action levels becoming obsolete (ineffective in prompting timely investigation or action) prior to the establishment of the revised (post-implementation) action levels. Examples might be the startup of a new fiber line, long-term shutdown of a fiber line, or replacement/upgrade of a major equipment component that impacts the wastewater discharge rate significantly.

Perhaps the clearest illustration of both the potential effectiveness of BMPs and the need for initial and revised action levels is found in the actual experience of a mill that carried out a BMP program involving many of the elements required in the BMP regulation. This mill, located in the southeastern U.S., implemented a spent pulping liquor spill prevention program in 1990 and 1991. Figure 8-1 presents the 7-day running average COD data for a year prior to the implementation of the spill prevention measures (1988) and the first year after implementation (1992). The figure also includes example action levels shown at the 75th and 90th percentile levels of COD for each year. These data provide evidence of the effectiveness of BMPs in several ways (19).

First, it is clear that the baseline COD has been substantially reduced, as illustrated by the fact that the darker line (1992 data) is, at almost all times, lower than the 1988 data plot. This is also

evident from the lower COD values represented by the 1992 example action levels as compared to the 1988 action levels shown on the figure.

A second result of the implementation of the spill prevention program is the reduction in the magnitude of the of the COD excursions as illustrated by the heights of the peaks in the data which for the most part correspond to major spent pulping liquor spills or intentional diversions. The major spike in the 1992 data, occurring in June, was a result of a major turpentine spill. Had the turpentine tanks and handling equipment been included in the spill prevention program, as required by the new BMP regulation, this release may not have occurred and the overall improvement illustrated by the comparison of the 1992 and 1988 data would have been even larger. This turpentine spill and its strong detrimental impact upon the operation of the POTW is discussed later in Section 9.3.1 (19).

A review of an incident that occurred at kraft pulping mill in the Southeastern U.S. in July of 1993 provides further evidence of both the efficacy and cost-effectiveness of the implementation of BMPs as called for in 40 CFR 430.03. This mill experienced a process upset that resulted in a significant amount of foul condensate and spent pulping liquor being sewerred. When the color of the waste water treatment plant influent raised suspicions of abnormally high chemical loadings, a number of “defensive measures” were taken by the WWTP operators to maintain the health of the treatment process. Nonetheless, within two days, the treatment plant outfall exhibited depleted oxygen levels and, shortly thereafter, suspended solids in the effluent exceeded permit levels. Efforts to augment the plant bacteria inventory did not reverse the trends and a fish kill resulted downstream of the plant outfall. State officials ordered a shutdown of the mill while measures were taken to clean up and restore the WWTP to effective and consistent operation.

Actions taken after the incident provide additional evidence that BMPs are effective in reducing the level of pollutants in the mill effluent and in reducing the potential for major incidents that can render the associated waster water treatment plant ineffective. First, a detailed analysis of the

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incident showed that the absence of a feedback signal that would have provided the operators with indication of a valve position (open/closed status) allowed the upset condition to progress unchecked for some time. Had the failure of the valve to open in response to a operator command been evident from a feedback indicator signal, the upset could have been controlled early and the contaminated condensate could have been retained and returned to the process, rather than sewerred. This type of analysis is illustrative of the incident review element of the BMP plan and should virtually eliminate a repeat of the specific type of incident involved here. Additionally, the type of engineering analysis required to develop a BMP plan for this particular mill may have uncovered the potential for problems associated with the absence of a valve position indicator in the control room for this and other key valves and may have proactively avoided the upset, rather than the retrospective approach noted above.

A second message from this particular case/incident is contained in the findings of a study of the incident commissioned by the mill as part of the Consent Order that resulted from the NPDES permit violation. This study was carried out by an engineering firm during the six months immediately following the incident. The contractor examined the rate of BOD losses associated with spills (by subtraction of “baseline” BOD levels in the effluent) before and after the incident and found a 57% reduction in these losses. After examining the changes in the mill as a result of the incident, the contractor attributed the improved performance to:

- Review of the incident with operating personnel;
- Adjustments to brownstock washer operation;
- Operational and design changes in the evaporator area;
- Improved in-mill communications; and
- Supplemental training for pulp mill and evaporator personnel.

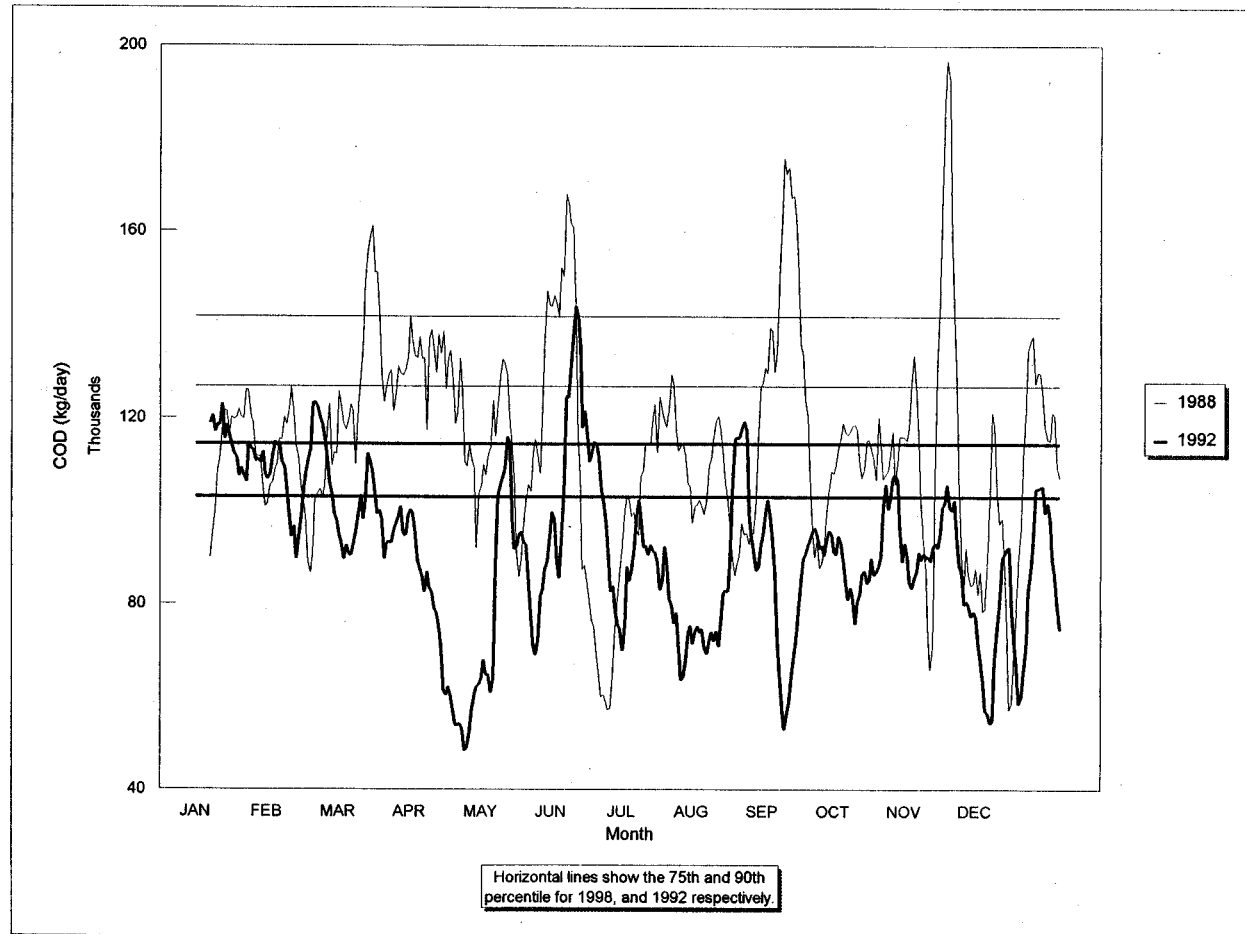
It is important of note that the mill estimated the financial cost of the incident and resulting NPDES permit exceedance to total \$2,997,730, mostly attributable to a 7.5 day mill shutdown to restore the waste water treatment plant to effective operation. The company was also required to spend an additional \$500,000 on plant improvement measures aimed at pollution prevention. In

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summary, the financial consequences of this single incident were approximately equal to the full implementation cost of BMPs as required by 40 CFR 430.03 (32, 33).

Figure 8-1

Wastewater Treatment Influent COD Levels With and Without BMPs



Source: EPA, 1993 (19)

9.0 ESTIMATED COSTS AND EFFLUENT REDUCTION BENEFITS

This section presents a discussion of the methods that were used to estimate industry-wide costs to fully implement BMPs for spent pulping liquor, soap, and turpentine at pulp and paper mills.

9.1 Current Status of Spent Pulping Liquor Spill Prevention and Control Systems in United States

A wide variety of spent pulping liquor spill prevention and control practices exist in the pulp and paper mills in the United States. Many older and complex mills have been operating proactive, highly effective spent pulping liquor spill prevention and control systems for many years. Many other mills have fairly limited spill prevention and control systems. EPA evaluated the current status of the industry using information obtained during mill visits, the results of the NCASI BMP survey, and follow-up contact with the AF&PA (24). The mills were divided into three categories, based on the status of their spent pulping liquor spill prevention and control systems, as follows:

- Category 1: Mills with most of the major components of a model spent pulping liquor control system in place. Incremental investment costs at these mills are not expected to exceed 10% of the estimated total investment costs (excluding costs for preparation of initial BMP Plan) (see Section 9.2).
- Category 2: Mills with some of the major equipment items of a model spent pulping liquor control system in place (e.g., a few liquor collection sumps, liquor storage tanks, sewer conductivity monitoring, etc.). At these mills, as much as 60% of the estimated total investment costs may be necessary to fully implement a BMP Plan.
- Category 3: Mills with relatively little spent pulping liquor control equipment in place. At these mills, as much as 90% of the estimated total investment costs may be required to implement a BMP Plan.

Table 9-1 presents the status of spent pulping liquor BMP implementation at pulp and paper mills. A summary of this status is presented below:

Type of Mill	Percent of Mills in Category 1	Percent of Mills in Category 2	Percent of Mills in Category 3
Kraft and Soda Mills	26%	29%	45%
Sulfite Mills	20%	33%	47%

9.2 Equipment Costs for BMP Implementation at Pulp and Paper Mills

To develop the industry-wide costs, bleached papergrade kraft and soda and papergrade sulfite mills were first classified by the level of complexity of their pulping and chemical recovery systems. *Single line* mills were defined as mills with one fiberline (e.g., one continuous digester or one set of batch digesters, one or two pulp washing lines, etc.). *Moderately complex* mills were defined as mills with two fiberlines. *Complex* mills were defined as mills with more than two fiberlines, multiple sets of evaporators, and multiple recovery boilers. Complex mills are usually older mills that have been modernized and expanded. These classifications are independent of pulp production capacity because the complexity of a mill is most often the primary factor that drives investment costs for the installation of spent pulping liquor spill prevention and control systems.

For each level of mill complexity, EPA determined the types of equipment necessary to operate effective spill control systems. This equipment included liquor collection sumps, liquor storage capacity, fiber reclaim tanks, process area curbing and diking, turpentine and soap containment for kraft mills that process softwood, conductivity monitoring and high-level tank alarms, and costs for engineering analyses, initial BMP Plan preparation, and operator training. Based on information obtained from mill visits and the results of the NCASI BMP survey, EPA determined that single line kraft mills will require up to five liquor collection sumps (relatively small 4'×4'×4' or 4'×4'×8' concrete sumps equipped with conductivity-actuated liquor recovery pumps). Moderately complex mills will require up to 9 sumps, and complex mills will require up to 12 sumps. Each type of mill was assigned one 500,000-gallon spent pulping liquor storage

tank for the collection of recovered liquor. One fiber reclaim tank was assigned for single line mills, and two fiber reclaim tanks were assigned for the moderately complex and complex mills. The amount of process area curbing and diking, conductivity monitoring, turpentine and soap containment, and engineering analyses for initial BMP Plan preparation required for each type of mill was a function of the mill complexity. A similar process was followed for sulfite mills; however, there are no sulfite mills with more than one line.

Table 9-2 presents a summary of estimated BMP investment costs for kraft mills to fully implement effective spent pulping liquor spill prevention and control systems and containment measures for soap and turpentine. Table 9-3 presents similar information for sulfite mills. These cost estimates were prepared assuming the mills had no spill control equipment in place. The total investment costs for each type of mill are summarized below:

Type of Mill	Kraft Mill Investment Costs	Sulfite Mill Investment Costs
Single Line Mills	\$ 2,150,000	\$ 1,300,000
Moderately Complex Mills	\$ 3,250,000	None
Complex Mills	\$ 4,050,000	None

Based on information obtained from mill visits, NCASI BMP questionnaire responses, and reports in the literature, EPA determined that the following items contribute to the annual costs for implementing spent pulping liquor BMPs:

- Evaporation of recovered liquor;
- Operation and maintenance of new equipment;
- Tank integrity testing program; and
- Operator training.

The BMP implementation items that contributed to annual cost savings at the mills were as follows:

- Recovered fiber;
- Recovered pulping chemicals;
- Recovered energy; and
- Reduced wastewater treatment costs for power, nutrient addition, and sludge disposal.

Most mill operators did not complete the cost sections of the NCASI BMP questionnaires. The operators who did complete this section generally show a net annual cost savings from implementation of spent pulping liquor BMPs of \$0.20 to \$1.00 per ton of brownstock pulp. A few mills reported net annual costs ranging from \$0.01 to \$0.35 per ton of brownstock pulp. A few available reports and other sources of cost data for spent pulping liquor BMP implementation show annual net cost savings in the range of \$500,000 to \$750,000, and payback periods of less than 4 to 8 years (19,29).

9.3 Costs and Effluent Reductions - Mill Case Studies

Case studies of cost and effluent reductions resulting from spent pulping liquor BMP implementation at two bleached papergrade kraft mills are presented below. The first case study also provides anecdotal evidence supporting the need for adequate containment of turpentine as a part of an effective BMP program.

9.3.1 Southern U.S. Bleached Papergrade Kraft Mill

Table 9-4 and Figures 9-1 through 9-5 show the impacts of pulping liquor BMPs implemented at a southern kraft mill that pulps southern pine and discharges process wastewaters to an adjacent POTW (19). The process wastewater discharge from the mill accounts for more than 95% of the POTW influent flow. The mill has no on-site wastewater treatment facilities, and prior to 1991, had virtually no pulping liquor spill prevention and control facilities. Primary and secondary wastewater treatment have been provided by the POTW. From 1990 to 1991, the mill installed an extensive pulping liquor spill prevention and control system for black liquor, green liquor, white liquor, and lime mud. The system includes several process area liquor collection sumps and refurbished oil storage tanks that are used to collect pulping liquor. The mill also partially closed a screen room. Relatively minor operational changes were also instituted at the POTW during that period; however, the POTW was not upgraded in terms of additional unit operations or additional treatment capacity.

The first full year of operation of the black liquor spill prevention and control system at the mill was 1992. Production of brownstock pulp during 1992 was about 6% less than that for 1988. The annual average POTW effluent flow for 1992 was less than 3% lower than the 1988 annual average, but about 3% higher when normalized to pulp production. Although there was little change in the total mill wastewater volume resulting from the BMPs (on an average basis), maximum flows to the POTW were reduced, and there was a marked decrease in the variation in the effluent flow. Table 9-4 presents a tabular summary of the changes in the mill's effluent as a result of the black pulping liquor BMP implementation. Figure 9-1 depicts the reduced wastewater flow to the POTW that occurred after the BMP implementation.

The distribution of POTW influent COD data presented on Figure 9-2 shows a marked reduction in POTW COD influent loadings. In particular, the 80th percentile to the maximum value COD loadings were lower after spent pulping liquor controls were implemented. The overall reduction in the average BOD₅ influent loadings was about 20%. POTW effluent data for COD, TSS, and BOD₅, normalized to annual pulp mill production, showed significant reductions in 95th percentile effluent mass loadings (see Figures 9-3 through 9-5 and Table 9-4).

The reductions in the annual average effluent mass loadings for COD, TSS, and BOD₅ were 27%, 57%, and 17%, respectively. The most significant reductions were at the higher percentile mass loadings, suggesting that effective spent pulping liquor controls reduced short-term adverse impacts on POTW operations. The reductions in effluent loading were not always associated with reductions in maximum flows. Although the average POTW influent COD loading was reduced by 22%, the average POTW effluent loading was reduced by 27%. These results suggest that the spent pulping liquor controls resulted in removal of a greater portion of COD material from pulping liquor that is refractory to conventional biological treatment.

The mill had a spill of turpentine during May 1992, which impacted POTW performance for late May and part of June 1992. Although not discernable on Figures 9-3 through 9-5, the adverse impact of the spill resulted in the higher percentile mass loadings of COD, TSS, and BOD₅ shown on these figures. The impact of the spill is more clearly shown on Figure 9-6, which provides a time-series plot of seven-day average POTW effluent BOD₅ for 1992. These results clearly demonstrate the importance of providing proper containment for turpentine process areas and bulk storage tanks as part of a pulp mill BMP Plan. Had effective controls been in effect at the time of the spill, it could have been contained, and the adverse impacts on POTW operations (interference and pass-through) could have been avoided.

Whole effluent toxicity data reported by the POTW show that intermittent acute toxicity to *Daphnia* and *Pimephales promelas* was eliminated, as was intermittent chronic toxicity to

Pimephales promelas. Consistent chronic toxicity to *Daphnia* was substantially reduced, except during the period of the turpentine spill.

The mill's total investment costs for the spill prevention and control systems, including refurbishment of two fuel oil storage tanks, was about \$4 million dollars (1990-1991). The mill estimates that the net annual cost savings for recovery of black liquor at 3 to 4% liquor solids is about \$500,000, excluding the cost savings for recovered fiber, which have not been measured or estimated. The costs incurred at this mill are in line with those presented in Table 9-2 for BMPs for control of spent pulping liquor, if they are adjusted upward about \$500,000 to \$750,000 to account for additional controls for white liquor, green liquor, and lime mud.

9.3.2 Canadian Bleached Papergrade Kraft Mill

Another BMP implementation case study involves a Canadian bleached kraft mill with two fiberlines. The No. 1 pulp mill began operations during 1948 and is now dedicated to hardwoods, principally aspen. The No. 2 pulp mill began operations during 1978 and processes mainly black spruce (29,30). The spent pulping liquor spill prevention and control system was installed in response to a control order issued by the Ontario Ministry of Environment before the installation of secondary treatment in 1987. Spent pulping liquor spill prevention and control was identified as the highest-priority project for reducing final effluent toxicity at the mill (29,30).

The major elements of the upgraded spill prevention and control system were:

- Reactivation of the original pulp mill spill tank;
- Installation of a new 120,000-gallon spill tank;
- Installation of a conductivity-activated sump in the No. 2 pulp mill, and routing of gland water and decker white water around the sump;

9.0 Estimated Costs and Effluent Reduction Benefits

- Prevention of softwood fibers from entering the No. 1 pulp mill's hardwood line;
- Collection of spilled spent pulping liquor in as concentrated a form as possible;
- Upgrading of the sewer monitoring network; and
- Development of a computer monitoring system for 15 wastewater streams and 37 tanks and vessels.

The capital cost for the upgraded spill prevention and control system was reported at \$2,400,000 (1985 Canadian dollars) (29,30). The net annual operating savings were reported as follows (1985 Canadian dollars):

Savings in Recovered Chemicals	\$700,000
Savings in Recovered Fiber	250,000
Cost of Extra Evaporation of Recovered Liquor	<u>(200,000)</u>
Net Annual Savings	\$750,000

From these data, EPA estimated a return on investment of 31% and a payback period of 3.2 years. Mill operators reported that the break-even point for the recovery of dilute black liquor is about 4% liquor solids, and that recovery of very dilute liquors (less than 2% liquor solids) is avoided by collecting spilled or lost liquor before its dilution with other wastewaters (29,30).

The effluent reduction benefits experienced by the Canadian bleached kraft mill are described in Table 9-5. The operators at this mill attributed these effluent reduction benefits to the upgraded spent pulping liquor controls. The effluent reduction benefits were attained before the installation of an aerated stabilization basin that was completed during 1989 (29,30).

9.4 General Conclusions

Based on the results of these case studies and on other information presented in this report, EPA believes that improved management of spent pulping liquor, soap, and turpentine and effective spill prevention and control can result in the following effluent reduction benefits:

- Reduced mass loadings of priority, non-conventional, and conventional pollutants in untreated wastewaters, and reduced toxicity of raw waste loadings prior to biological treatment;
- Reduced toxicity in biologically treated pulp mill effluents;
- Reduced wastewater flows and discharges of priority, non-conventional, and conventional pollutants;
- Reduced potential for catastrophic spills of spent pulping liquor, soap, and turpentine directly into waterways; and
- Reduced potential for upsets to wastewater treatment facilities from in-mill spills, and reduced potential for increased discharges of unchlorinated and chlorinated toxic compounds, effluent toxicity, and conventional and non-conventional pollutants (BOD₅, COD, and TSS) associated with treatment system upsets.

Non-water quality environmental impacts from improved spent pulping liquor control systems include:

- Reduced incidental emissions of volatile HAPs, including methanol and methyl ethyl ketone;
- For kraft mills, reduced incidental atmospheric emissions of odor-causing TRS compounds, including hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide;
- Improved energy efficiency resulting from the combustion of black liquor solids that would otherwise be lost to the sewer (a net increase in energy use will occur if very dilute weak liquors are processed);
- Improved process efficiency, including a reduced need for make-up chemicals and more efficient utilization of operating and supervisory personnel; and

- Reduced environmental impacts associated with the manufacture and transportation of make-up chemicals no longer required at the pulp mill because of increased spent pulping liquor recovery.

For a typical kraft mill with no BMPs in place, EPA estimates that the average incremental untreated wastewater BOD₅ loading reduction attainable from effective black liquor spill prevention and control is about 5 kg/ADMT of brownstock pulp (2). Accordingly, for mills with adequate black liquor spill prevention and control programs, there will be no incremental untreated wastewater BOD₅ loading reduction, and only limited incremental costs for preparation of the BMP Plan and minor facility upgrades. For mills with marginally adequate programs, EPA estimates that the average incremental untreated wastewater BOD₅ loading reduction will be about 2.5 kg/ADMT. For mills with inadequate programs, the estimated average incremental untreated BOD₅ loading reduction will be about 5 kg/ADMT. For sulfite mills, EPA assigned effluent average loading reductions of 2.5 kg/ADMT for half of the mills, and 5 kg/ADMT for the other half of the mills. The reduction in untreated wastewater BOD₅ loadings will, in turn, result in reduced effluent loadings.

EPA's conclusions regarding spent pulping liquor management and BMP implementation are as follows:

- Spent pulping liquor management and spill control systems, as well as spill control systems for other chemicals such as turpentine and soap, are important for economic operation of kraft pulping and recovery systems, for minimizing adverse impacts on wastewater treatment systems, and for producing optimum effluent quality. Such systems are essential for minimizing effluent discharges from chemical pulp mills.
- Spent pulping liquor management and control systems are best implemented through a combination of spent pulping liquor management systems and operating practices (non-hardware) and spill collection and recovery systems (hardware). Spill and loss prevention, rather than spill collection, is essential for effective spent pulping liquor management.

9.0 Estimated Costs and Effluent Reduction Benefits

- Approximately 26% of the bleached kraft and soda mills in the United States have essentially complete spent pulping liquor management and control systems, approximately 29% have partial systems, and approximately 45% would require major upgrades to fully implement effective control systems. Sulfite mills in the United States are estimated to have a status similar to the bleached kraft mills.
- Collection and recovery of kraft black liquor at liquor solids concentrations of 3 to 4% will be cost-effective at most kraft mills. Consequently, emphasis must be placed on collecting spent liquor at concentrations greater than 3 to 4%. This is achieved by strategically locating sumps, curbs and other diversion and collection systems so that the spent liquor is recovered prior to mixing with wastewaters or already diluted spent liquor. Some mills collect and recover spent liquor at lower liquor solids concentrations because of effluent color considerations. Evaporator hydraulic capacity is likely to be a limiting factor that either will prevent many mills from recovering spent pulping liquor at low liquor solids concentrations or require upgrades to evaporators and/or appurtenant equipment to meet local requirements (e.g., color limits).
- Two case studies show that for mills with few spent pulping liquor control systems in place, liquor spill prevention and control can be cost-effective. The return on investment may not be exceptionally high; however, substantial cost savings could occur at mills where effective spent pulping liquor management and spill control systems can be installed instead of effluent color treatment systems or upgraded biological treatment systems.
- Additional benefits associated with effective spent pulping liquor management that cannot be quantified include: a cleaner internal mill environment for mill staff, and a cleaner receiving water environment resulting from reduced effluent discharges, reduced secondary environmental impacts achieved through the use of recovered chemicals, and reduced risk of effluent limitation exceedances.

Table 9-1

**BMP Implementation Status for Spent Pulping Liquor Control Systems at
Bleached Kraft and Soda Mills, and Sulfite Mills**

Pulping Process	BMP Implementation Status		
	Number of Mills in Category 1 (10 % costs)	Number of Mills in Category 2 (up to 60 % costs)	Number of Mills in Category 3 (up to 90 % costs)
Bleached Kraft and Soda	22	25	37
Dissolving Kraft	1	0	2
Total	23	25	39
Papergrade Sulfite	3	3	5
Dissolving Sulfite	0	2	2
Total	3	5	7

Sources: EPA Mill Visit Reports
 NCASI, 1994 (23)
 AF&PA, 1995 (24)

Table 9-2

**BMP Investment Cost Estimates for Bleached Papergrade Kraft
and Soda Mills**

EPA Model BMP Technology	Mill Complexity		
	Single Line	Moderately Complex	Complex
Liquor Collection Sumps	\$750,000 (up to 5 sumps)	\$1,350,000 (up to 9 sumps)	\$1,800,000 (up to 12 sumps)
Liquor Storage Capacity (one 500,000-gallon tank)	600,000	600,000	600,000
Fiber Reclaim Tank(s)	150,000 (one tank)	300,000 (two tanks)	300,000 (two tanks)
Process Area Curbing and Diking	200,000	300,000	400,000
Turpentine and Soap Containment	150,000	250,000	350,000
Sewer Conductivity Monitoring and Storage Tank Alarms	150,000	250,000	350,000
Initial BMP Plan Preparation and Initial Operator Training	150,000	200,000	250,000
Total	\$2,150,000	\$3,250,000	\$4,050,000

Note: Derived from EPA Mill Site Visit Reports, EPA project files and Reference 23.

Table 9-3**BMP Investment Cost Estimates for Papergrade Sulfite Mills**

EPA Model BMP Technology	Single Line
Liquor Collection Sumps	\$450,000 (up to 3 sumps)
Liquor Storage Capacity (one 200,000-gallon tank)	300,000
Fiber Reclaim Tank	150,000
Process Area Curbing and Diking	150,000
Sewer Conductivity Monitoring and Storage Tank Alarms	100,000
Initial BMP Plan Preparation and Initial Operator Training	150,000
Total	\$1,300,000

Note: All sulfite mills have a single fiber line.
Derived from EPA Mill Visit Reports, EPA project files, and Reference 23.

Table 9-4

**Effects of Spent Pulping Liquor Control Systems on POTW Effluent Quality
at a Southern U.S. Bleached Papergrade Kraft Mill Discharging to POTW**

POTW Effluent Characteristic	1988 Effluent Quality	1992 Effluent Quality	Percent Change
Flow (m³/ADMT)			
95th Percentile	154	140	
Median	120	127	+ 5.8
Mean	117	121	+ 3.4
Standard Deviation	24.2	17.9	
Coefficient of Variation	0.21	0.15	- 29
COD (kg/ADMT)			
95th Percentile	54.7	41.1	
Median	37.3	26.9	- 28
Mean	37.7	27.6	- 27
Standard Deviation	10.8	8.52	
Coefficient of Variation	0.29	0.31	+ 6.8
TSS (kg/ADMT)			
95th Percentile	10.4	5.08	
Median	5.11	2.15	- 58
Mean	5.61	2.41	- 57
Standard Deviation	2.93	1.30	
Coefficient of Variation	0.52	0.54	+ 3.8
BOD₅ (kg/ADMT)			
95th Percentile	4.23	3.65	
Median	1.90	1.49	- 23
Mean	2.09	1.73	- 17
Standard Deviation	1.14	1.04	
Coefficient of Variation	0.55	0.60	+ 9.0

Source: EPA, 1993 (19)

Table 9-5

**Quantified Effluent Reduction Benefits From Spent Pulping
Liquor Control System at a Kraft Mill Without Secondary Treatment**

Effluent Characteristic	March 1982	July 1985	Percent Reduction
Flow (m ³ /adt)	135	106	21 %
BOD (kg/adt)	40	29	27 %
TSS (kg/adt)	8.6	5.3	38 %
Dissolved Solids (kg/adt)	200	145	27 %
Sodium (kg Na ₂ SO ₄ /adt)	146	108	26 %
Toxic Contribution (TU m ³ /adt)	1,060	335	68 %

*Note: TU - Toxic units calculated as the reciprocal of the LC₅₀ using static bioassays multiplied by 100. Toxic units were converted to toxic contribution in m³/admt by multiplying the toxic units by the flow of the effluent and dividing by mill production. Bioassays were conducted using juvenile rainbow trout (*Salmo gairdneri*).*

Sources: Scroggins, 1986 (29)
Sikes and Almost, 1986 (30)

Figure 9-1

Effect of Spent Pulping Liquor Control Systems on POTW Effluent Flow at a Kraft Mill

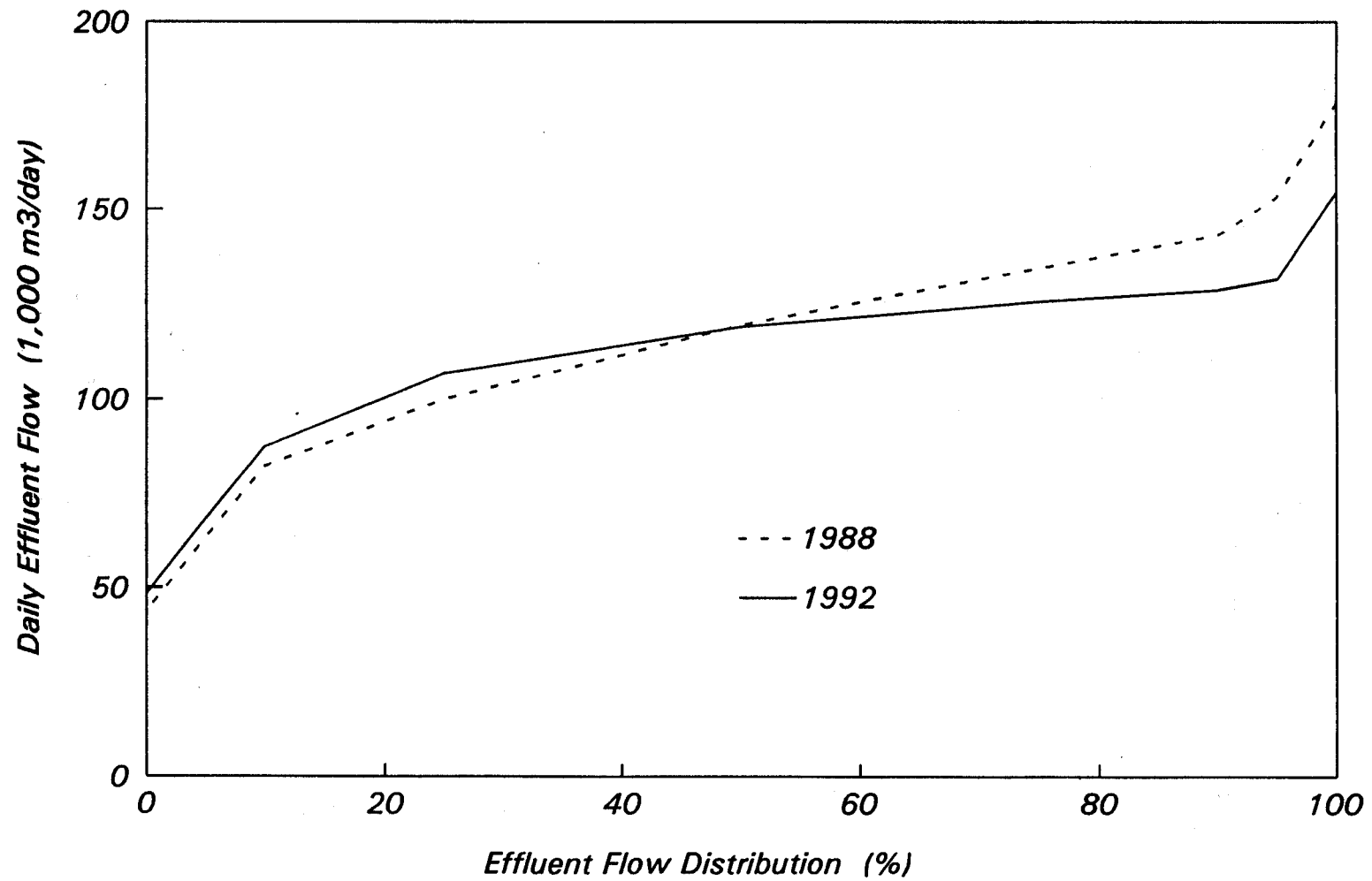


Figure 9-2

Effect of Spent Pulping Liquor Control Systems on POTW Influent COD Levels at a Kraft Mill

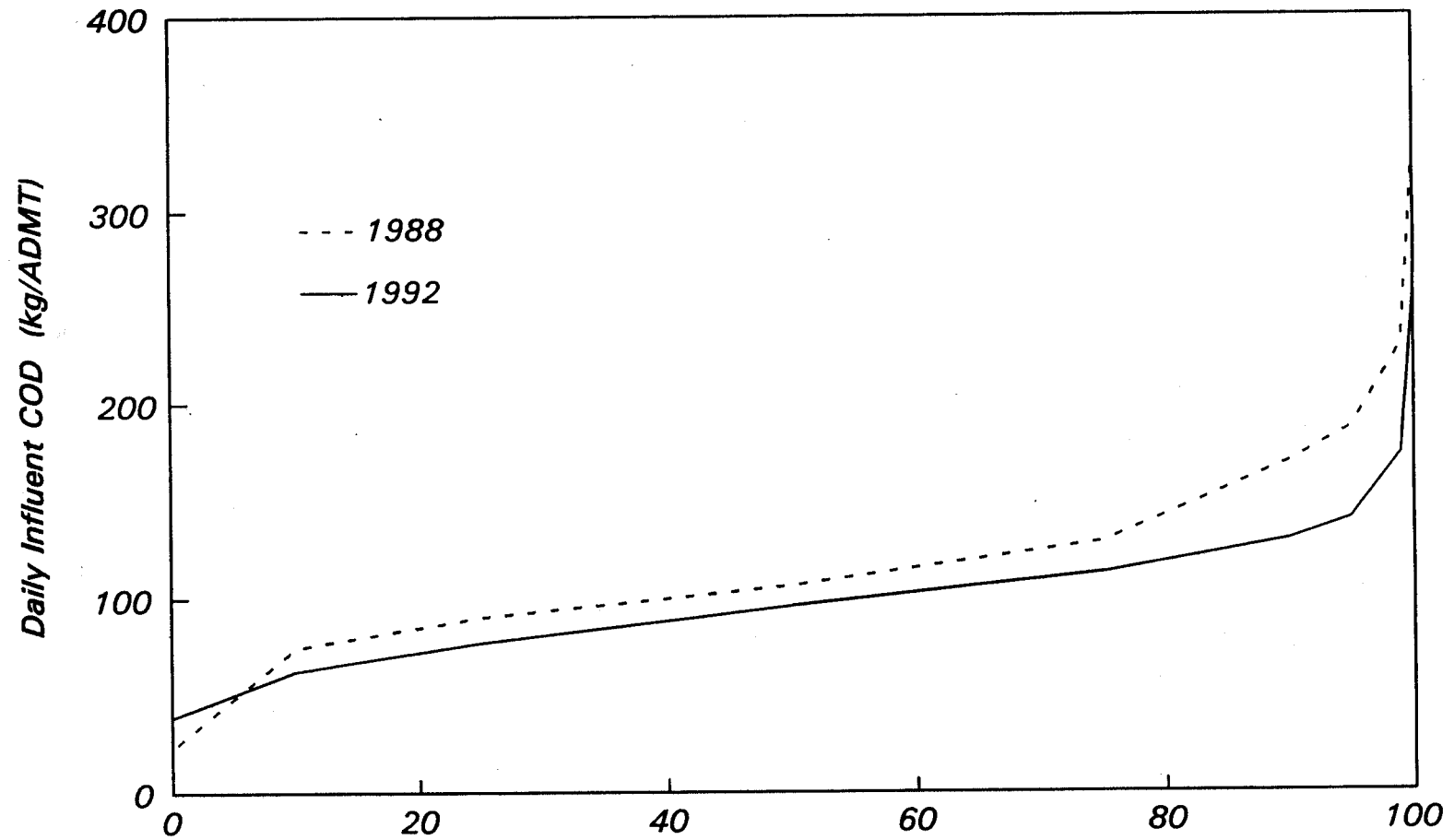


Figure 9-3

Effect of Spent Pulping Liquor Control Systems on POTW Effluent COD Levels at a Kraft Mill

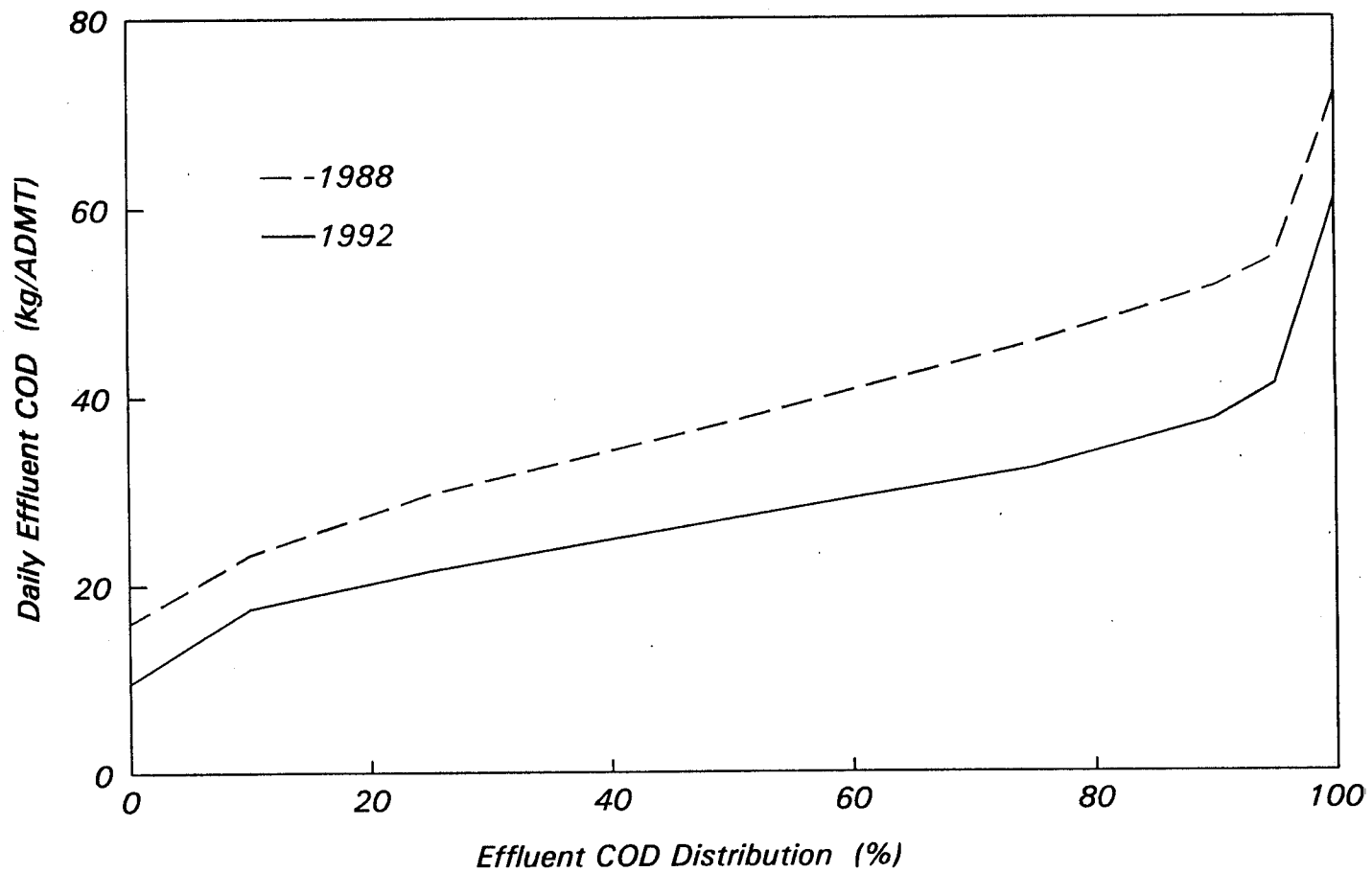


Figure 9-4

Effect of Spent Pulping Liquor Control Systems on TSS Levels at a Kraft Mill

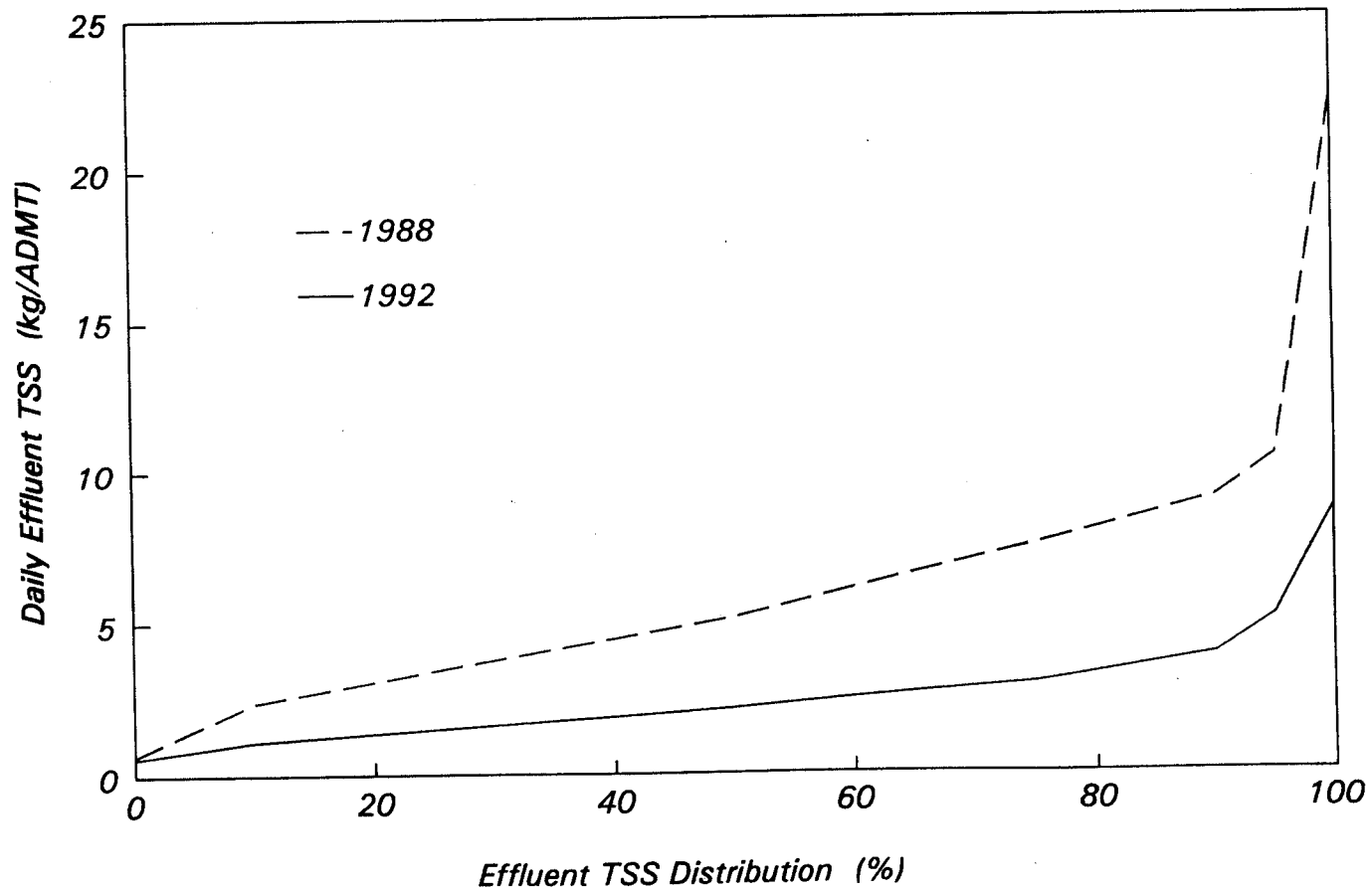


Figure 9-5

Effect of Spent Pulping Liquor Control Systems on BOD₅ Levels at a Kraft Mill

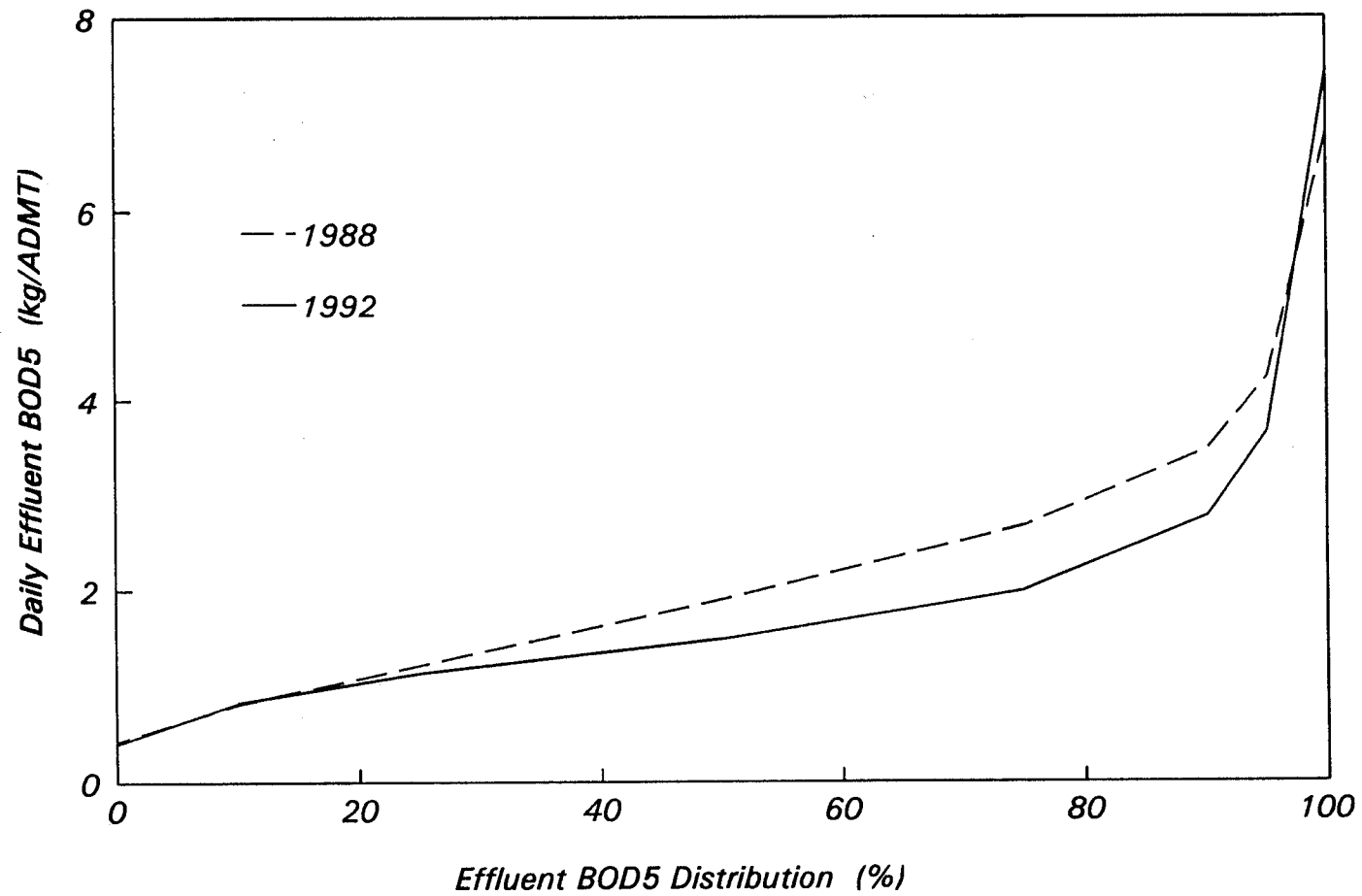
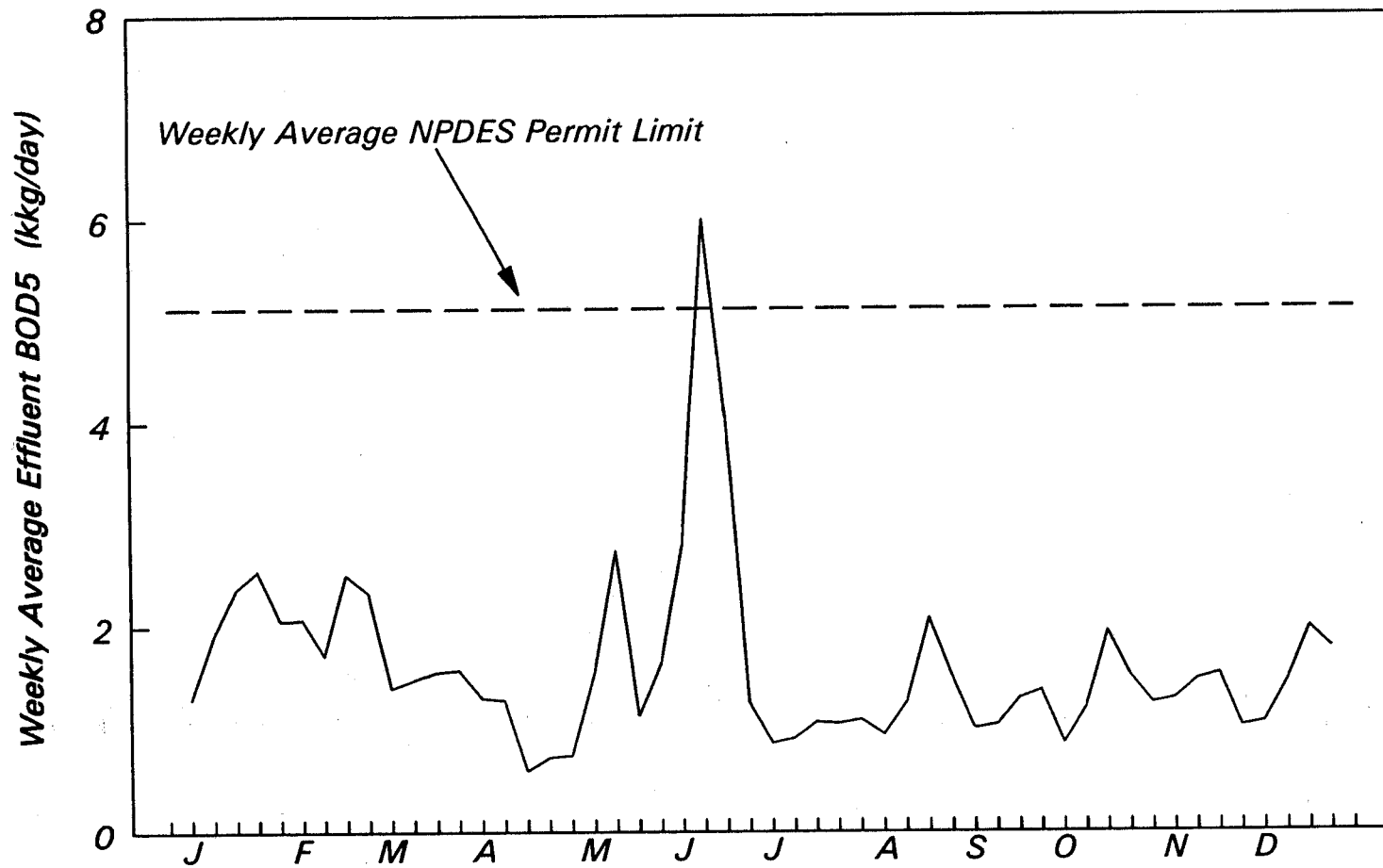


Figure 9-6

Effect of a Major Turpentine Spill at a Kraft Mill on Effluent BOD₅



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ATTACHMENT A
BEST MANAGEMENT PRACTICES REGULATION

§430.03 Best Management Practices for spent pulping liquor, soap, and turpentine management, spill prevention, and control

(a) Applicability. This section applies to direct and indirect discharging pulp, paper, and paperboard mills with pulp production in Subparts B (Bleached Papergrade Kraft and Soda) and E (Papergrade Sulfite).

(b) Specialized definitions. (1) Action Level: A daily pollutant loading that when exceeded triggers investigative or corrective action. Mills determine action levels by a statistical analysis of six months of daily measurements collected at the mill. For example, the lower action level may be the 75th percentile of the running seven-day averages (that value exceeded by 25 percent of the running seven-day averages) and the upper action level may be the 90th percentile of the running seven-day averages (that value exceeded by 10 percent of the running seven-day averages).

(2) Equipment Items in Spent Pulping Liquor, Soap, and Turpentine Service: Any process vessel, storage tank, pumping system, evaporator, heat exchanger, recovery furnace or boiler, pipeline, valve, fitting, or other device that contains, processes, transports, or comes into contact with spent pulping liquor, soap, or turpentine. Sometimes referred to as “equipment items.”

(3) Immediate Process Area: The location at the mill where pulping, screening, knotting, pulp washing, pulping liquor concentration, pulping liquor processing, and chemical recovery facilities are located, generally the battery limits of the aforementioned processes. “Immediate process area” includes spent pulping liquor storage and spill control tanks located at the mill, whether or not they are located in the immediate process area.

(4) Intentional Diversion: The planned removal of spent pulping liquor, soap, or turpentine from equipment items in spent pulping liquor, soap, or turpentine service by the mill for any purpose including, but not limited to, maintenance, grade changes, or process shutdowns.

(5) Mill: The owner or operator of a direct or indirect discharging pulp, paper, or paperboard manufacturing facility subject to this section.

(6) Senior Technical Manager: The person designated by the mill manager to review the BMP Plan. The senior technical manager shall be the chief engineer at the mill, the manager of pulping and chemical recovery operations, or other such responsible person designated by the

mill manager who has knowledge of and responsibility for pulping and chemical recovery operations.

(7) Soap: The product of reaction between the alkali in kraft pulping liquor and fatty acid portions of the wood, which precipitate out when water is evaporated from the spent pulping liquor.

(8) Spent Pulping Liquor: For kraft and soda mills “*spent pulping liquor*” means black liquor that is used, generated, stored, or processed at any point in the pulping and chemical recovery processes. For sulfite mills “*spent pulping liquor*” means any intermediate, final, or used chemical solution that is used, generated, stored, or processed at any point in the sulfite pulping and chemical recovery processes (e.g., ammonium-, calcium-, magnesium-, or sodium-based sulfite liquors).

(9) Turpentine: A mixture of terpenes, principally pinene, obtained by the steam distillation of pine gum recovered from the condensation of digester relief gases from the cooking of softwoods by the kraft pulping process. Sometimes referred to as sulfate turpentine.

(c) Requirement to implement Best Management Practices. Each mill subject to this section must implement the Best Management Practices (BMPs) specified in paragraphs (1) through (10) of this section. The primary objective of the BMPs is to prevent leaks and spills of spent pulping liquors, soap, and turpentine. The secondary objective is to contain, collect, and recover at the immediate process area, or otherwise control, those leaks, spills, and intentional diversions of spent pulping liquor, soap, and turpentine that do occur. BMPs must be developed according to best engineering practices and must be implemented in a manner that takes into account the specific circumstances at each mill. The BMPs are as follows:

(1) The mill must return spilled or diverted spent pulping liquors, soap, and turpentine to the process to the maximum extent practicable as determined by the mill, recover such materials outside the process, or discharge spilled or diverted material at a rate that does not disrupt the receiving wastewater treatment system.

(2) The mill must establish a program to identify and repair leaking equipment items. This program must include:

(i) Regular visual inspections (e.g., once per day) of process areas with equipment items in spent pulping liquor, soap, and turpentine service;

(ii) Immediate repairs of leaking equipment items, when possible. Leaking equipment items that cannot be repaired during normal operations must be identified, temporary means for mitigating the leaks must be provided, and the leaking equipment items repaired during the next maintenance outage;

(iii) Identification of conditions under which production will be curtailed or halted to repair leaking equipment items or to prevent pulping liquor, soap, and turpentine leaks and spills; and

(iv) A means for tracking repairs over time to identify those equipment items where upgrade or replacement may be warranted based on frequency and severity of leaks, spills, or failures.

(3) The mill must operate continuous, automatic monitoring systems that the mill determines are necessary to detect and control leaks, spills, and intentional diversions of spent pulping liquor, soap, and turpentine. These monitoring systems should be integrated with the mill process control system and may include, e.g., high level monitors and alarms on storage tanks; process area conductivity (or pH) monitors and alarms; and process area sewer, process wastewater, and wastewater treatment plant conductivity (or pH) monitors and alarms.

(4) The mill must establish a program of initial and refresher training of operators, maintenance personnel, and other technical and supervisory personnel who have responsibility for operating, maintaining, or supervising the operation and maintenance of equipment items in spent pulping liquor, soap, and turpentine service. The refresher training must be conducted at least annually and the training program must be documented.

(5) The mill must prepare a brief report that evaluates each spill of spent pulping liquor, soap, or turpentine that is not contained at the immediate process area and any intentional diversion of spent pulping liquor, soap, or turpentine that is not contained at the immediate process area. The report must describe the equipment items involved, the circumstances leading to the incident, the effectiveness of the corrective actions taken to contain and recover the spill or intentional diversion, and plans to develop changes to equipment and operating and maintenance practices as necessary to prevent recurrence. Discussion of the reports must be included as part of the annual refresher training.

(6) The mill must establish a program to review any planned modifications to the pulping and chemical recovery facilities and any construction activities in the pulping and chemical recovery areas before these activities commence. The purpose of such review is to prevent leaks and spills of spent pulping liquor, soap, and turpentine during the planned modifications, and to ensure that construction and supervisory personnel are aware of possible liquor diversions and of the requirement to prevent leaks and spills of spent pulping liquors, soap, and turpentine during construction.

(7) The mill must install and maintain secondary containment (i.e., containment constructed of materials impervious to pulping liquors) for spent pulping liquor bulk storage tanks equivalent to the volume of the largest tank plus sufficient freeboard for precipitation. An annual tank integrity testing program, if coupled with other containment or diversion structures, may be substituted for secondary containment for spent pulping liquor bulk storage tanks.

(8) The mill must install and maintain secondary containment for turpentine bulk storage tanks.

(9) The mill must install and maintain curbing, diking or other means of isolating soap and turpentine processing and loading areas from the wastewater treatment facilities.

(10) The mill must conduct wastewater monitoring to detect leaks and spills, to track the effectiveness of the BMPs, and to detect trends in spent pulping liquor losses. Such monitoring must be performed in accordance with paragraph (i) of this section.

(d) Requirement to develop a BMP Plan. (1) Each mill subject to this section must prepare and implement a BMP Plan. The BMP Plan must be based on a detailed engineering review as described in paragraphs (d)(2) and (3) of this section. The BMP Plan must specify the procedures and the practices required for each mill to meet the requirements of paragraph (c) of this section, the construction the mill determines is necessary to meet those requirements including a schedule for such construction, and the monitoring program (including the statistically derived action levels) that will be used to meet the requirements of paragraph (i) of this section. The BMP Plan also must specify the period of time that the mill determines the action levels established under paragraph (h) of this section may be exceeded without triggering the responses specified in paragraph (i) of this section.

(2) Each mill subject to this section must conduct a detailed engineering review of the pulping and chemical recovery operations -- including but not limited to process equipment, storage tanks, pipelines and pumping systems, loading and unloading facilities, and other appurtenant pulping and chemical recovery equipment items in spent pulping liquor, soap, and turpentine service -- for the purpose of determining the magnitude and routing of potential leaks, spills, and intentional diversions of spent pulping liquors, soap, and turpentine during the following periods of operation:

- (i) Process start-ups and shut downs;
- (ii) Maintenance;
- (iii) Production grade changes;
- (iv) Storm or other weather events;
- (v) Power failures; and
- (vi) Normal operations.

(3) As part of the engineering review, the mill must determine whether existing spent pulping liquor containment facilities are of adequate capacity for collection and storage of anticipated intentional liquor diversions with sufficient contingency for collection and containment of spills. The engineering review must also consider:

(i) The need for continuous, automatic monitoring systems to detect and control leaks and spills of spent pulping liquor, soap, and turpentine;

(ii) The need for process wastewater diversion facilities to protect end-of-pipe wastewater treatment facilities from adverse effects of spills and diversions of spent pulping liquors, soap, and turpentine;

(iii) The potential for contamination of storm water from the immediate process areas; and

(iv) The extent to which segregation and/or collection and treatment of contaminated storm water from the immediate process areas is appropriate.

(e) Amendment of BMP Plan. (1) Each mill subject to this section must amend its BMP Plan whenever there is a change in mill design, construction, operation, or maintenance that materially affects the potential for leaks or spills of spent pulping liquor, turpentine, or soap from the immediate process areas.

(2) Each mill subject to this section must complete a review and evaluation of the BMP Plan five years after the first BMP Plan is prepared and, except as provided in paragraph (e)(1) of this section, once every five years thereafter. As a result of this review and evaluation, the mill must amend the BMP Plan within three months of the review if the mill determines that any new or modified management practices and engineered controls are necessary to reduce significantly the likelihood of spent pulping liquor, soap, and turpentine leaks, spills, or intentional diversions from the immediate process areas, including a schedule for implementation of such practices and controls.

(f) Review and certification of BMP Plan. The BMP Plan, and any amendments thereto, must be reviewed by the senior technical manager at the mill and approved and signed by the mill manager. Any person signing the BMP Plan or its amendments must certify to the permitting or pretreatment control authority under penalty of law that the BMP Plan (or its amendments) has been prepared in accordance with good engineering practices and in accordance with this regulation. The mill is not required to obtain approval from the permitting or pretreatment control authority of the BMP Plan or any amendments thereto.

(g) Record keeping requirements. (1) Each mill subject to this section must maintain on its premises a complete copy of the current BMP Plan and the records specified in paragraph (2) of this section and must make such BMP Plan and records available to the permitting or pretreatment control authority and the Regional Administrator or his or her designee for review upon request.

(2) The mill must maintain the following records for three years from the date they are created:

(i) Records tracking the repairs performed in accordance with the repair program described in paragraph (c)(2) of this section;

(ii) Records of initial and refresher training conducted in accordance with paragraph (c)(4) of this section;

(iii) Reports prepared in accordance with paragraph (c)(5) of this section; and

(iv) Records of monitoring required by paragraphs (c)(10) and (i) of this section.

(h) Establishment of wastewater treatment system influent action levels. (1) Each mill subject to this section must conduct a monitoring program, described in paragraph (2) of this

section, for the purpose of defining wastewater treatment system influent characteristics (or action levels), described in paragraph (3) of this section, that will trigger requirements to initiate investigations on BMP effectiveness and to take corrective action.

(2) Each mill subject to this section must employ the following procedures in order to develop the action levels required by paragraph (h) of this section:

(i) Monitoring parameters. The mill must collect 24-hour composite samples and analyze the samples for a measure of organic content (e.g., Chemical Oxygen Demand (COD) or Total Organic Carbon (TOC)). Alternatively, the mill may use a measure related to spent pulping liquor losses measured continuously and averaged over 24 hours (e.g., specific conductivity or color).

(ii) Monitoring locations. For direct dischargers, monitoring must be conducted at the point influent enters the wastewater treatment system. For indirect dischargers monitoring must be conducted at the point of discharge to the POTW. For the purposes of this requirement, the mill may select alternate monitoring point(s) in order to isolate possible sources of spent pulping liquor, soap, or turpentine from other possible sources of organic wastewaters that are tributary to the wastewater treatment facilities (e.g., bleach plants, paper machines and secondary fiber operations).

(3) By the date prescribed in paragraph (j)(1)(iii) of this section, each existing discharger subject to this section must complete an initial six-month monitoring program using the procedures specified in paragraph (h)(2) of this section and must establish *initial action levels* based on the results of that program. A wastewater treatment influent action level is a statistically determined pollutant loading determined by a statistical analysis of six months of daily measurements. The action levels must consist of a *lower action level*, which if exceeded will trigger the investigation requirements described in paragraph (i) of this section, and an *upper action level*, which if exceeded will trigger the corrective action requirements described in paragraph (i) of this section.

(4) By the date prescribed in paragraph (j)(1)(vi) of this section, each existing discharger must complete a second six-month monitoring program using the procedures specified in paragraph (h)(2) of this section and must establish *revised action levels* based on the results of

that program. The initial action levels shall remain in effect until replaced by revised action levels.

(5) By the date prescribed in paragraph (j)(2) of this section, each new source subject to this section must complete a six-month monitoring program using the procedures specified in paragraph (h)(2) of this section and must develop a *lower action level* and an *upper action level* based on the results of that program.

(6) Action levels developed under this paragraph must be revised using six months of monitoring data after any change in mill design, construction, operation, or maintenance that materially affects the potential for leaks or spills of spent pulping liquor, soap, or turpentine from the immediate process areas.

(i) Monitoring, corrective action, and reporting requirements. (1) Each mill subject to this section must conduct daily monitoring of the influent to the wastewater treatment system in accordance with the procedures described in paragraph (h)(2) of this section for the purpose of detecting leaks and spills, tracking the effectiveness of the BMPs, and detecting trends in spent pulping liquor losses.

(2) Whenever monitoring results exceed the *lower action level* for the period of time specified in the BMP Plan, the mill must conduct an investigation to determine the cause of such exceedance. Whenever monitoring results exceed the *upper action level* for the period of time specified in the BMP Plan, the mill must complete corrective action to bring the wastewater treatment system influent mass loading below the *lower action level* as soon as practicable.

(3) Although exceedances of the action levels will not constitute violations of an NPDES permit or pretreatment standard, failure to take the actions required by paragraph (i)(2) of this section as soon as practicable will be a permit or pretreatment standard violation.

(4) Each mill subject to this section must report to the NPDES permitting or pretreatment control authority the results of the daily monitoring conducted pursuant to paragraph (i)(1) of this section. Such reports must include a summary of the monitoring results, the number and dates of exceedances of the applicable action levels, and brief descriptions of any corrective actions taken to respond to such exceedances. Submission of such reports shall be at the frequency established by the NPDES permitting or pretreatment control authority, but in no case less than once per year.

(j) Compliance deadlines. (1) Existing direct and indirect dischargers. Except as provided in paragraph (j)(2) of this section for new sources, indirect discharging mills subject to this section must meet the deadlines set forth below. Except as provided in paragraph (j)(2) of this section for new sources, NPDES permits must require direct discharging mills subject to this section to meet the deadlines set forth below. If a deadline set forth below has passed at the time the NPDES permit containing the BMP requirement is issued, the NPDES permit must require immediate compliance with such BMP requirement(s).

(i) Prepare BMP Plans and certify to the permitting or pretreatment authority that the BMP Plan has been prepared in accordance with this regulation not later than [*insert date 12 months after date of publication*];

(ii) Implement all BMPs specified in paragraph (c) of this section that do not require the construction of containment or diversion structures or the installation of monitoring and alarm systems not later than [*insert date 12 months after date of publication*].

(iii) Establish initial action levels required by paragraph (h)(3) of this section not later than [*insert date 12 months after date of publication*].

(iv) Commence operation of any new or upgraded continuous, automatic monitoring systems that the mill determines to be necessary under paragraph (c)(3) of this section (other than those associated with construction of containment or diversion structures) not later than [*insert date 24 months after date of publication*].

(v) Complete construction and commence operation of any spent pulping liquor, collection, containment, diversion, or other facilities, including any associated continuous monitoring systems, necessary to fully implement BMPs specified in paragraph (c) of this section not later than [*insert date 36 months after date of publication*].

(vi) Establish revised action levels required by paragraph (h)(4) of this section as soon as possible after fully implementing the BMPs specified in paragraph (c) of this section, but not later than [*insert date 45 months after date of publication*].

(2) New Sources. Upon commencing discharge, new sources subject to this section must implement all of the BMPs specified in paragraph (c) of this section, prepare the BMP Plan required by paragraph (d) of this section, and certify to the permitting or pretreatment authority that the BMP Plan has been prepared in accordance with this regulation as required by paragraph

(f) of this section, except that the action levels required by paragraph (h)(5) of this section must be established not later than 12 months after commencement of discharge, based on six months of monitoring data obtained prior to that date in accordance with the procedures specified in paragraph (h)(2) of this section.